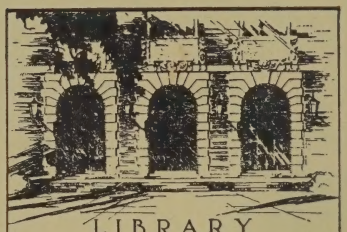

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Memoirs

OF THE

British Astronomical Association.

EDITED BY

E. WALTER MAUNDER, F.R.A.S.

REPORTS

OF THE

OBSERVING SECTIONS.

VOL. VIII.

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SECTION FOR THE OBSERVATION

OF

METEORS.

DIRECTOR.—HENRY CORDER.

REPORT OF THE SECTION, 1898.

Introductory.

This year's report will be found to contain a fairly full account of the Perseid Shower, which was well observed in England, and also some interesting observations of the Leonids made in India. Beyond this, not very much has been accomplished in watching the showers, some being hidden by cloud, and others, as the Andromedes and Taurids failing to put in an appearance. There is also a valuable table of heights of meteor paths, contributed by Mr. Denning, whom we are glad to welcome again as a Member of the Association. The Section numbers about 12 Members, but from some not much has been received during the year, and the Director would wish, while thanking those who have contributed, to encourage those who have not, and also Members of the Association in general, to send in any stray observations of bright meteors of which the paths have been pretty accurately noted.

Bridgwater,
January 31, 1899.

HENRY CORDER,
Director.

Monthly Record of Meteor Showers.

JANUARY.

The Quadrantid shower was unobserved in England this year, but Mr. Backhouse, who was then voyaging on the Arabian Sea, had clear skies, and watched at intervals on the nights of January 1 and 2. It appears from a table of his observations, that only four Quadrantids out of a total of eight meteors, were seen in 49 minutes on January 1, and seven Quadrantids out of nine meteors in 58 minutes on January 2. Four of these were seen in 16 minutes shortly before midnight, giving an hourly rate (corrected for altitude of radiant) of 29 per hour. Two bright meteors were seen.

FEBRUARY.

Mr. Besley mapped 16 meteors on the nights of February 20 and 22, a radiant in Bootes was probable. A few others were seen earlier in the month.

MARCH.

At the end of the month, Mr. Besley was again successful in mapping 14 meteors; a fairly strong radiant appeared in Draco, and another in Ursa.

APRIL.

The Lyrid shower was very poorly observed, and meteors were very scarce.

On April 19, Mr. Blakeley saw only six meteors in about $1\frac{1}{2}$ hours, one being equal to Jupiter. The radiant seemed to be at about $268^\circ + 36^\circ$, a good deal W. of the position mapped by Mr. Besley, and 10° N. of a position estimated by Mr. J. H. Bridger. So that it would seem that there were weak branch radiants active. Mr. Bridger only saw five meteors on this date between $9^h\ 45^m$ and $11^h\ 47^m$.

The night of April 20 seems to have been generally overcast. That of the 21st was finer, and Mr. Bridger saw six meteors in about $1^h\ 15^m$, and Mr. Besley saw the same number between $11^h\ 45^m$ and $13^h\ 30^m$.

On April 22, he tried again, watching from 12^h till $13^h\ 30^m$, and saw 14 meteors, of which eight were Lyrids. The radiant, rather diffused, was at about $273^\circ + 33^\circ$.

At Bridgwater, a watch was kept on the 17th, but only one meteor was seen in half-an-hour, and on the 22nd, only one in 40 minutes. Both these watches were, however, before midnight.

MAY AND JUNE.

Almost no meteors were seen in these months, and none of the May Aquarids.

JULY.

Mr. Besley began watching for Perseids by July 14, when three of these meteors were seen from a radiant at $12^\circ + 50^\circ$. Unfortunately observations were interrupted by a large conflagration in the neighbourhood, so that this is a rather uncertain position.

On July 20, four more were seen in $1\frac{1}{4}^h$, with a radiant at $21^\circ + 51^\circ$; one more only in an hour's watch on July 24; but on the 28th, six were seen in an hour, with a radiant at $32^\circ + 55^\circ$. These are an interesting addition to our knowledge of early radiants in this region, but may not all be connected with the August stream.

Mr. E. R. Blakeley says, that at Dewsbury, "the atmospheric "conditions were generally unfavourable, so that from July 26 "to August 19, only six nights were at all clear, and even then "haze prevailed round the horizon." July 27, only four meteors seen, one being probably a Perseid. At 11.30, a rather

remarkable meteor was seen, which began as 1st mag., decreased to 4th, and vanished altogether twice during its flight, reappearing some degrees further on. July 29, clear during latter part of watch, and 22 meteors mapped between 11^h and 13^h 10^m, of which six were Perseids with a good radiant at $31° + 54°$. The finest meteor was at 12^h 10^m, and was estimated as brighter than Jupiter, and moved slowly in the S.E. heavens, near the horizon. On July 30, in a short watch, only two meteors were seen.

AUGUST.

The Perseid shower was very generally observed on August 11, as this was a night of exceptional clearness, and in some parts of the country, a partial view was obtained on August 10, but the other nights were more or less overcast.

Several Members of the Section have sent special reports which will be given almost in extenso, and the radiants deduced from them will appear in the general list for the year.

August 8, a few observations made by Messrs. Backhouse and Besley, the latter counted seven meteors in 25 minutes. On August 9, Mr. J. H. Bridger had a clear sky at Farnborough, and counted 12 meteors in an hour (10.0 to 11.0), of which 10 were Perseids.

On August 10, he also watched from 10.10 till 11.0, mapping 24 meteors, of which 17 were Perseids, and then continued watching without mapping until 11.30, when 28 more meteors were seen, and the hourly rate of Perseids rose to 48.

At Yeovil, the Rev. T. E. R. Phillips watched from shortly before 10.0 until 13.0, and recorded 40 meteors, of which 27 were in the last hour. A brilliant meteor was recorded at 12.2, and five others are spoken of as "bright," one at 12.5 being green.

At Portland, the Rev. W. R. Waugh saw 18 meteors between 9.30 and 11.0, of which 15 were Perseids, and five were of 1st mag., with bright streaks, one of a pinkish hue.

At Bridgwater, a tolerably continuous watch was kept between 9.30 and 12.45, when it clouded over; and before that, moonlight and clouds began to interfere. In all, 96 meteors were counted, of which 88 were Perseids. The hourly number for all meteors rose to about 40, in spite of moonlight. It would not be of any value to give a detailed table of the watch, nor of the magnitudes, as both results would be vitiated by the moonlight, but there were 15 reckoned as 1st mag., and eight brighter than 1st, of which the finest were at 10.40 and 12.0, both flashing out at the end of their course, and the former one left a spot of light for some seconds where the flash took place.

At Bridport, Rev. S. J. Johnson watched from 10.13 till 11.13, and counted 11 meteors, of which 10 were Perseids, the finest (at 12^h $1\frac{1}{2}^m$), which was of a greenish colour, being equal to Jupiter.

August 11, Mr. Johnson again watched for an hour, and counted 18 meteors between about 10^h–11^h. One of them, at 10^h $1\frac{1}{2}^m$, was equal to Venus at her greatest brilliancy.

At Cardiff, Mr. George Carslake-Thompson watched from about 9^h 30^m until 14^h 0^m, and saw 77 meteors. The largest number were seen in the quarter hour preceding midnight, when 18 were counted, and 52 in the whole hour, 12.45 to 13.45. Most of the

meteors left phosphorescent streaks, and had bright heads, but those appearing near the radiant appeared to be almost all streak. The radiant was estimated to be at R.A. $2^h\,53^m + 55°\,40'$, but some came from nearer Cassiopeiæ. At Portland, Rev. W. R. Waugh noted eight meteors between 9.0 and 10.30, none occurring in the last half hour. (In this time, Mr. Thompson counted six, and the Director 11, after which the number more than doubled.)

At Dewsbury, Mr. Blakeley watched from $10^h\,20^m$ until $13^h\,40^m$ almost without intermission, and 52 meteors were seen, the Perseids being decidedly in the majority, with a radiant at 45 + 58 very diffuse.

The finest seen were at 10 $32\frac{1}{2}$ = Sirius; at 11 30 > γ; at 12 1 = Sirius; at 12 23 = Sirius; at 12 25 = Sirius, and at 13 2 equal Jupiter. That seen at 11^h 30 was a typical Perseid of the brightest class, expanding at the end of its path with a lightning-like flash; the broad streak was of an intense golden colour, and the meteor appeared slightly deflected at the end of its course. A meteor appeared at 11 11, which seemed like a small faint nebulous cloud, moving slowly.

Mr. Blakeley has seen four or five others at various times with this appearance, and the Director also can corroborate the observation during his experience. Conditions can hardly have been so good at Dewsbury, as only about 15 meteors an hour seem to have been recorded.

At Exeter, on this date, Mr. Besley watched from $9^h\,15^m$ until $12^h\,40^m$, and counted 75 meteors, the rate per hour rising from 15 to 30. Of these, six Perseids and 11 other meteors were of 1st mag., three Perseids were brighter than 1st mag., but less than Jupiter, whilst one at $12^h\,24^m$, and a non-Perseid at $10^h\,15^m$ were as bright as Venus. The latter and another "erratic" were of a bluish colour. Mr. Besley considers that only 40 out of the 75 were Perseids, a good many being from Cassiopeia. No doubt some other observers would hardly note this distinction, and the Director is sorry to add that he among them did not map very many, and has perhaps "lumped" them as Perseids. A pretty good watch, however, was kept at Bridgwater. In the first place, one observer watching from $9^h\,15^m$ until $13^h\,30^m$, counted 149 meteors, of which 135 were counted as Perseids. The best hour was from 10.30 until 11.30, when 50 were seen. After this they fell off, partly on account of slight moonlight, to 33 an hour by the end of the watch, of which only 26 were Perseids. The most beautiful meteor seen was an Aquarid, at 8.58, details of which are given elsewhere. The magnitudes were as follows:—

> 1st, 12; 1st, 30; 2nd, 61; 3rd, 75; 4th, 31; 5th, 9; coloured 12.

No bright flashing Perseids were seen, and only two equal to Sirius. There was a rich orange 1st mag. near the radiant, and an interesting 3rd mag. with long streak directed from Taurus. Perhaps the Director is over cautious in the matter of magnitudes, or only unlucky, but it is well to describe conscientiously what is seen, and interesting then to compare the results with those of others. Another point seemed to be of interest: during part of the time two other observers were assisting, so as to cover as much sky as possible, and there seemed to be a considerable difference in the number of meteors seen in different parts of the

sky. For instance, during an hour when Mr. Corder was watching the radiant and sky to E. of it, only 28 meteors were seen, whilst at the same time Miss M. L. Bayes, watching the western sky, counted 36, and Mr. T. B. Dilks had a similar experience watching in the direction of the Great Bear. So that it would seem that although the best estimate of the radiant is to be had by mapping the foreshortened meteors near it, yet more, with of course longer paths, are to be seen in other directions. These three observers also watched for an hour together. It should be stated that no part of the horizon was visible, and the view was a good deal shut in by trees and houses. Between 10.30 and 11.30 when the Director saw only 50 meteors, the three together counted 105, the best quarter-hour giving 29.

At Paignton, Mr. H. J. Townshend counted 50 meteors between 10.30 and 12 0, but some of the time was taken up in mapping. About six Cassiopeids were seen, and others thought to be from Hercules and Lyra. He considers that the hourly number between 10.30 and 11.30 was 60 meteors. The finest was seen at 9.19, and was estimated at twice the brightness of Venus, at the time when it broke out with a final flash. At 10.34 there was one as bright as Arcturus, with a red streak.

Mr. J. H. Bridger watched at Farnborough from 9.30 until 11.0 and 53 meteors were seen, the hourly rate when none were mapped between 10.30 and 11.0 being 60. Mr. Bridger was fortunate in observing the bright Aquarid mentioned above.

At Yeovil, Rev. T. E. R. Phillips, recorded 38 meteors between 9.40 and 11.56, and no doubt would have seen more but for time taken up by mapping.

At Aysgarth, Mr. J. E. Clark recorded 26 meteors in about an hour and a quarter, 10.0 to 11.15. Miss E. Brown also reports the shower as visible at Cirencester, and Mr. Backhouse saw a few at Seaton Carew. After this date very few were seen, and the weather was unfavourable.

SEPTEMBER.

As usual very few meteors were mapped in this month, which is not generally distinguished by strong showers, although those who diligently watch in the morning hours are often well repaid. Mr. Besley and Mr. Bridger both send notes of a few meteors, but not sufficient to deduce radiants from.

OCTOBER.

Mr. Besley recorded nearly 70 meteors in this month, chiefly on the 18th and 23rd.

On the 12th a few were seen, the chief radiant being in Aries.

The Orionids were active on the later dates, about 11 being put down to this shower, and six to that in Gemini, which is generally more or less contemporaneous. The Orion radiant was at 91° + 16°, about its usual position, indeed we always have found this one of the best defined and most stationary of all the chief meteor radiants, although the Geminids, which Mr. Besley places this year at 97° + 15°, and which are a much more diffuse system are often confounded with the true Orionids.

The following table gives the general results of the watches kept at Westminster for the Orionid and contemporary showers :—

1898.	Watches.				Number of Meteors recorded.						
					Radiants.						
	From.	To.	Length.	Free from Cloud.	Taurus, 64° + 12½°.	Orion, 91° + 16°.	Gemini, 97° + 15°.	Gemini, 109° + 30°.	Telescopium, 115° + 37½°.	Others.	Totals.
	h. m	h. m.	h. m.	h. m							
Oct. 18	12 30	14 15	1 45	1 15	2	7	3	—	1	12	25
„ 23	12 15	12 45	0 30	0 30	—	—	—	1	—	3	4
„ 24	12 45	15 15	2 30	2 25	1	4	3	2	2	19	31
Totals -	—	—	4 45	4 10	3	11	6	3	3	34	60

Mr. Besley adds :—"The most brilliant meteor appeared at "13h 24m on October 18, and travelled swiftly from 87°—1° to "105°—10°. Its brightness was nearly equal to that of Venus, "its colour was bluish-white, and its head well defined. This "was an Arietid.

"Meteors of the 1st mag. were registered on the 18th at 12.57, "at 13h 12m (slow, orange), at 13h 52m (Orionid, bluish-white), "and on the 24th at 14h 47½m. The meteors from Taurus were "swift, the Orionids and Geminids also swift, and for the most "part left streaks."

NOVEMBER.

This was a month of disappointment and delusion, for clouds almost entirely hid the Leonids, and where clear very few were seen, and of the expected Andromedes none whatever appeared.

The Director has had many reports of the Leonids sent to him, for all which he hereby tenders his thanks, and will proceed to give a short summary of the more important ones, the rest being almost entirely a record of failure.

It may first be mentioned that the best view of the shower was evidently obtained in America, but even there it never reached the level of a great display, and elsewhere the Leonids hardly outnumbered the uncomformable meteors.

The most interesting record of the event has been sent by Mr. H. G. Tomkins, of Madras, who trained a number of educated native Indians to watch together, and although the resulting radiants are, perhaps, not very trustworthy, yet the details of the strength of the shower are valuable. Mr. Tomkins says :—"As I "have a house-top to work on, and a clear horizon all round, I "got together the party of 25 observers, chiefly from my office "here. They are educated men and soon took to it. They were "trained, as far as possible, by the aid of artificial showers made

"with a magic-lantern, and also by studying the sky with their "maps for several nights beforehand. Some of them had some "knowledge of astronomy, and one had been trained in the "observatory.

"Seven cameras were set up, one a 4-in. lens, and one a magic-"lantern lens. Both these gave clear star trails, but unfortunately "caught no meteor. Another with a small wide-angle lens shows "the trail of Regulus, and a long path of a meteor very faintly, "showing a somewhat broken line, as if the light of the meteor "varied many times during its flight.

"The sky was under observation all the night, and every meteor "was counted. The parties worked in very good accord. The "counters were at a separate table, and the duration of flight of "the meteors was estimated by the aid of a pendulum, a man "keeping time on a box with a stick, as a metronome could not "be obtained; time was called every five minutes through the "three nights."

As far as possible other meteors than Leonids were excluded; during some of the watches they more than equalled the number of Leonids, but on the principal nights of the shower were of comparative rarity.

From November 7 to November 12, two separate observers were keeping watch between the hours of $13^h\ 30^m$ and $15^h\ 30^m$, and taking the most successful one, the results were of Leonids, in two hours, November 7th, 3; 8th, cloudy; 9th, 6; 10th, 21; 11th, 28; 12th, 28. On November 13 the combined watch began at 10.45, and 23 Leonids were seen in the first two hours, when it clouded over for three hours. At $15^h\ 45^m$ watching was resumed, and about 30 meteors were seen in an hour. On November 14 clouds obscured the sky until $13^h\ 25^m$, and only four Leonids appeared before 14^h. The numbers then run; to 15^h, 48 Leonids; to 16^h, 75; to 17^h, 79; to $17^h\ 20^m$, 42, when daylight became too strong.

The shower, however, evidently increased steadily, for in five minutes after $17^h\ 10^m$, 14 Leonids were seen. On November 15 it was clear all night, and even before midnight Leonids had begun to appear.

Beginning at $10^h\ 30^m$, the hourly numbers run,—15, 29, 41, 60, 81, 142, 74. The last number, however, does not represent a complete hour, as daylight came on about $17^h\ 20^m$. After this the combined watch was discontinued, but on the 16th, 38 Leonids were seen by one observer in two hours; on the 17th, 18 were seen; on the 18th, 15, with 24 from other radiants; on the 19th, 17 Leonids, and 12 others; on November 20th, 16 Leonids, and 14 other meteors. From these figures it appears that the maximum of the shower, as seen in India, was at 16^h on November 15, but that on the 14th also the earth was already deeply immersed in the meteor stream. It may be said that at the time of writing Mr. Tomkins was not a member of the British Astronomical Association, but was desirous of joining the Association, and the thanks of the Meteor Section are all the more due to him for his kindness in sending his most interesting results,

and for the careful way in which he carried out his plans, which most fortunately were but little interfered with by the weather. Mr. Tomkins also sends maps of meteor tracks made by an Indian gentleman, near Trichinopoly, who observed a large number of Leonids and other meteors. The radiants do not come out very clearly, and the Director again wishes to impress on observers the absolute necessity of watching with a rod in the hand, to hold up immediately along the line of flight, and also in mapping, at once to carry back the line to some distant star, if possible near to or beyond the supposed radiant. Only one brilliant meteor appeared, which unfortunately ended with a bright flash behind a cloud.

On November 12 a watch was kept at Bridgwater, from $14^h\ 35^m$, until daybreak at about $17^h\ 10^m$, and 27 meteors were seen, but only about six were Leonids. The finest meteors came from the direction of Taurus and apparently belonged to at least two radiants, but not more than one or two could have been of the usual Taurid shower.

Mr. Backhouse made a number of short watches, but did not see many meteors. His chief watch was in the twilight of November 13, when one meteor was thought to be a Leonid. The next two mornings were overcast. Mr. W. J. Hall was watching on the same morning, and also found meteors very scarce; only two meteors seen in about an hour, and neither of them a Leonid.

Mr. Pope, at Dingwall, had the morning of the 16th clear, and saw about a dozen meteors, of which about eight were Leonids. These were seen between 3^h and 4^h a.m.

Mr. J. H. Bridger, at Farnham, on November 13, watched from $14^h\ 5^m$ till $17^h\ 20^m$ and saw 11 meteors, of which seven were Leonids with a radiant of $150° + 22°$. One meteor as bright as Sirius, seemed to explode at $15^h\ 26^m$.

Mr. Besley was disappointed altogether, as were also Mr. Blakeley and Mr. Townshend. Mr. H. Pain, at Cambridge, sends notes referring to each night, chiefly describing the varying density of the clouds until November 14, at $16^h\ 35^m$, a bright flash was seen. After this, although hazy clouds almost entirely hid the stars, eight meteors were seen before $17^h\ 30^m$, chiefly in the S., as the observations were made from a window. Mr. G. B. Longstaff and others, at Wimbledon, succeeded in seeing two rather bright meteors on November 14, that at 10.20 being brighter than Mars, and travelling about 120°.

On November 13, Mr. W. M. Worssell, observing from the Esplanade, Bognor, saw a fair number of meteors between 12.30 and $17^h\ 45^m$ in a clear sky, but the rest of the reports received are of total failure.

The Andromedes never came at all, although a great shower was expected. It was, indeed, moonlight at the time, but on many evenings during the week stars were fairly bright, but no one seems to have recorded a single meteor, and up to the time of writing nothing has been heard of any foreign observation of the shower. Although the weather accounts for most of the failures

in November, yet there were times when the sky was clear, and it should therefore be noted that, with one or two possible exceptions, no Taurids were recorded during the month, and it can hardly be doubted but that the shower was very weak this year.

DECEMBER.

The Geminid epoch was almost as overcast as the Leonid, but Mr. Besley succeeded in making a good observation on December 9, and again on December 12. There appeared to be three radiants in Gemini, the chief one at 115° + 32°, another at 104° + 31°, and the third at 108½° + 28°. This only produced three meteors, but from their different character it may be considered that they belonged to the shower of long streak-leaving meteors seen in former years, but lost for some long time. Only about 10 meteors per hour were recorded on the 12th, and a less number on the 9th. One Geminid was as bright as Jupiter. There appeared to be radiants also in Monoceros, Auriga, and Cancer. Mr. T. H. Astbury sends a list of meteors, one of them, a 1st mag., being stationary 1° N.W. of Castor at 8.29 on December 9, and, no doubt, fixing the radiant of the Geminids pretty nearly. Mr. J. H. Bridger watched from 9 till 11 on December 9, and saw 10 meteors, of which only one or two could have been Geminids. The strongest radiant seemed to be in Ursa Major at 122° + 41°. Mr. T. W. Backhouse made the most complete series of observations at the Geminid epoch, but did not record any until December 7, when one was seen. On December 11, in 83^m before midnight, nine meteors were seen, of which six were Geminids; but the sky was covered with thin cloud. On December 12, in 125^m between 7 o'clock and 13^h 22^m, 25 meteors were seen, 19 being Geminids. The hourly rate for all meteors rose to about 19 after midnight. Two more Geminids were seen on the 13th, but none on the 14th. One meteor at 12.29 on December 12 was equal to Venus, and brilliantly coloured.

At Bridgwater, watches of short duration were made on December 7 (no meteors), December 12 (one Geminid), December 15 (four meteors, of which one was a Geminid). On December 19, Mr. Besley recorded 20 more meteors, with radiants in Leo, Ursa, and Draco. The last-named seemed a very active shower, with a radiant at 197½° + 69°, seven meteors, of which two were brighter than 1st mag.

Radiants of Meteor Showers, 1898.

B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1898.		° °			
790	Feb. 20–22	Bootes	215 + 33	4	Quick	W. E. B.
791	Mar. 29–31	Ursa Major	178 + 57½	4	Quick	W. E. B.
792	„ „	Draco	245 + 55	6	Swift	W. E. B.
793	Apr. 19	Lyrids	268 + 36	4	Swift	E. R. B.
794	„ 19–21	„	268 + 25	5	Swift	J. H. B.
795	„ 21–22	„	273½ + 32½	12	Swift	W. E. B.
796	July 14	Perseids	12 + 50	3	Swift	W. E. B.
797	„ 20	„	21 + 51	3	Swift	W. E. B.
798	„ 28	„	32 + 55	4	Swift	W. E. B.
799	„ 29	„	31 + 54	5	Swift	E. R. B.
800	Aug. 8	„	42 + 57	3	Swift	W. E. B.
801	„ 9	„	42 + 55½	10	Swift	J. H. B.
802	„ 10	„	43 + 55½	16	Swift	J. H. B.
803	„ 10	„	43 + 59	11	Swift	H. C.
804	„ 10	„	45 + 55	—	Swift	T. E. R. P.
805	„ 10	„	43 + 53	—	Swift	J. H. T.
806	„ 11	„	45 + 58	40	Swift	W. E. B.
807	„ 11	„	45 + 56	13	Swift	J. H. B.
808	„ 11	„	49 + 58	13	Swift	H. C.
809	„ 11	„	46 + 58	—	Swift	T. E. R. P.
810	„ 11	„	46 + 56	29	Swift	J. H. T.
811	„ 11	„	45 + 58	30	Swift	E. R. B.
812	July 29	Polarids	5 + 88	6	Quick	E. R. B.
813	Aug. 9	Cepheids	323 + 65	3	Quick	J. H. B.
814	„ 11	Cassiopeids	2 + 50	11	Swift	W. E. B.
815	Aug.	Camelids	67 + 55	4	Swift	J. H. B.
816	„ 11	„	70 + 65	4	Swift	T. E. R. P.
817	„ 11	θ Aquarii	328 + 6	7	Slowish	E. R. B.
818	„ 11	δ Equulei	317 + 10	6	Quick	E. R. B.
819	„ 11	Piscids	348 + 3	5	Slowish	J. E. C.
820	„ 11	„	350 + 5	2	Slowish	H. C.
821	„ 17	Pegasids	345 + 15	4	Quick	E. R. B.
822	„ 17	Honorids	347 + 51	4	Quick	E. R. B.
823	Sept. 9	Perseids	47 + 39	4	Swift	W. E. B.
824	Oct. 12	Arietids	43½ + 16½	4	Slow	W. E. B.
825	„ 18–24	Muscids	43 + 22	3	Slow	W. E. B.
826	„ „	Taurus	64½ + 12½	4	Slow	W. E. B.

B.A.A. Ref. No.	Date.	Name.	Radiant.	No. of ψ's.	Class.	Observer.
	1898.					
827	Oct. 18–24	Orionids	91° + 16°	7	Swift	W. E. B.
828	„ „	γ Geminids	97 + 15	3	Swift	W. E. B.
829	„ „	δ Geminids	107 + 20	3	Swift	W. E. B.
830	„ „	Telescopium	115 + 37½	5	Swift	W. E. B.
831	Nov. 14	Leonids	153 + 20	—	Swift	Indian.
832	„ 14	„	148 + 21	—	Swift	Indian.
833	„ 15	„	148 + 24	—	Swift	Indian.
834	„ 15	„	148 + 24	—	Swift	Indian.
835	„ 16	„	154 + 20	5	Swift	J.T. Pope.
836	„ 12	„	144 + 27	4	Swift	H. C.
837	„ 13	„	150 + 22	7	Swift	J. H. B.
838	„ 13	Ursa Major	151 + 66	4	Quick	H. C.
839	„ 13	ζ Tauri	83 + 24	5	Slow	H. C.
840	„ 13	o Tauri	52 + 5	5	Slow	H. C.
841	„ 13	β Cancri	123 + 14	2	Quick	H. C.
842	„ 14	„	122 + 9	—	Quick	Indian.
843	Dec. 12	Cancer	130 + 20	5	Quick	W. E. B.
844	„ 12	Auriga	71½ + 47	3	Swift	W. E. B.
845	„ 9–12	Monoceros	99½ − 5½	4	Swift	W. E. B.
846	„ „	Gemini	108½ + 28	3	Swift	W. E. B.
847	„ „	Geminids	104 + 31	7	Quick	W. E. B.
848	„ „	„	115 + 32	11	Quick	W. E. B.
849	„ 9	Ursa	122 + 41	4	Swift	J. H. B.
850	„ 19	Ursa	174½ + 58½	4	Swift	W. E. B.
851	„ 19	Leo	151½ + 26½	3	Swift	W. E. B.
852	„ 19	Draco	197½ + 69	7	Swift	W. E. B.

Doubly observed Meteors, 1898.

FIREBALL OF JANUARY $21^d\ 5^h\ 32^m$.

This was, perhaps, the most interesting meteor of the year, and a great many accounts were received, either by letter or newspaper cuttings. Mr. Denning used 33 in his calculation of its path, so it was evidently very generally observed in the south of England at any rate. The real path was such a long one, and was prolonged so far over the English Channel that it is difficult to say where the real end-point was, for it is evident that many observers only saw the earlier part of its flight, not many noticing the explosion which occurred towards the end. The height at first appearance was 82 miles over Croydon, after which it traversed the very long path of 235 miles at a rate of 34 miles

per second, and ended over the Channel at a height of 25 miles. The radiant was at 130° + 30° in Cancer. Mr. Denning compares this with the path of a fireball of January 19, 1877, at $6^h\ 27^m$, the length of path, velocity and radiant agreeing almost exactly.

In colour the meteor is very variously described. Perhaps the following description shows the sequence of the changes:—At commencement reddish, then yellow or golden, turning to electric blue, and then green, when it burst into a number of yellow fragments. It seems to have been accompanied by a train. Of course, the apparent size varied very much at different distances. At Catford it appeared of the size of Venus, but from Torquay, much nearer the end of the path, it appeared of the "perfect "shape and size of the full moon, when it suddenly changed to "the shape of a pear (stalk foremost), then burst. A stream of "light gushed out, preceded by a row of stars of vivid coloured "brilliancy, and the whole together at the same speed vanished "into space."

GREAT FIREBALL OF JANUARY 26. (*Communicated by Mr. Walter F. Gale*).

A fireball of unusual magnificence appeared at $10^h\ 6^m$ on the night of January 26. At this time I was standing with others on the bridge at the entrance to Lake Macquarie looking northward up the channel, and watching the innumerable fish faintly outlined in the phosphorescent water. Suddenly the whole scene was brilliantly illuminated, two small vessels and the trees a quarter of a mile distant showing out clearly. The fish simultaneously darted in all directions, many hundreds of mullet, taylor, and perch making clean breaches from the water. Several members of the party exclaimed "lightning," and such was my own first impression. The moon was absent from the sky, and I knew it was absolutely cloudless to the horizon, so instinctively turned to the south-east.

Immediately above δ Centauri, moving northwards, was a mass of intensely bright green light, estimated at 18′ × 12′, with several small detached fragments of a ruddy colour. The path it had traversed was still glowing, and extended back to the Cross. The motion of the meteor was slow, carrying it over ζ Hydræ to a point preceding δ Crateris. I fixed the beginning and end points of the track seen by me as R.A. $11^h\ 58^m$ — 50° and R.A. $11^h\ 5^m$ — 14°, and the period occupied in traversing it three seconds. No detonation was heard. A Mr. Drew, who saw the first outburst of the fireball, pointed out to me at the time the star ι Hydri as near the origin of its visibility. He was certain the point was between the Magellanic clouds, and as nearly as I could fix it at R.A. $3^h\ 20^m$ — 78°. It rapidly blazed out, and seemed to him as large as the moon, but much more brilliant.

I have failed to obtain intelligible tracks from those who saw the meteor from Newcastle, but trust an observer to the south of our station will furnish useful particulars.

METEOR OF FEBRUARY 20, $8^h\ 54^m$.

A large number of observations of this meteor came to hand, some of them from our own Members. Mr. Besley saw it, and

rated it as brighter than Venus, and of a bluish-white colour, moving swiftly. Unfortunately there seems to have been more confusion about this meteor than is usually the case, and Mr. Denning says that he spent several whole days trying to unravel the mystery. It is always possible that more than one meteor may have been seen, and on this occasion Mr. Besley's path does not agree with most of the others, and Mr. Ryle, who writes from Brighton gives the date as Monday, February 21. In other respects it agrees with the other observations. His meteor somewhat exceeded Venus in brilliancy, and was of a yellowish white. The path ultimately decided on by Mr. Denning was 95 miles in length, performed at the rate of 24 miles per second, from a height of 61 miles to one of 24 miles over the English Channel. The radiant was near β Leonis.

METEOR OF APRIL 5, $10^h\ 15^m$.

The following account was furnished by the Rev. T. E. R. Phillips:—"I was fortunate enough to see a splendid meteor on "April 5 at $10^h\ 15^m$. It was simply magnificent, in spite of the "moonlight, and travelled visibly over a path exceeding 100° of "longitude. The moonlight, and consequent paucity of bright "stars, made it somewhat difficult to determine its track with "accuracy, but I think the following particulars are not far off "the mark. Time occupied in traversing its apparent path, "12 to 15 seconds. Colour, golden yellow or orange. Magnitude "about equal to Venus. Estimated track from 154° + 17° to "260° + 22°. The meteor left a train of sparks behind it. "I should say that I probably missed its first appearance, but "it arrested my attention when observing Jupiter, by the brilliant "light it caused in the sky. I also lost its final disappearance, as "it dropped behind some houses, and so was lost to view, though "fast fading at the time." Mr. Denning received other observations of this fine object, and it will be seen, by referring to his table, that it was a Monocerotid, with a radiant at 121°—1°, and during a visible path of 162 miles, traversed at a speed of about 11 miles per second (the slowest of any in the list, it may be noted), it fell from a height of 89 miles over a point 25 miles S.E. of Dartmouth to a height of 25 miles over a point five miles N.E. of Bisley.

AQUARID METEOR OF AUGUST 11, $8^h\ 58^m$.

This beautiful meteor was seen by many in the twilight of August 11, just as the Perseids were beginning to appear. It belonged, however, to the well-known shower of Aquarids, with a radiant at 339°—10°. It was estimated as equal to Jupiter or Venus in brilliance, and had a long, almost horizontal path, as seen by most English observers, as it travelled from a height of 66 miles over the River Seine to a height of 41 miles over Okehampton, a distance of 196 miles at a somewhat slow rate. Reports were received from Mr. W. J. Stanton, of Stroud, who noted that the train was bright at the latter part of its course, and that it lasted several seconds; from Mr. E. W. Johnson, of Croydon, who says that it travelled from S.E. to S.W. passing

just below Saturn; and from Mr. F. W. Levander, in London, who noticed, as others did, that a number of sparks were given off near the end, but did not consider that any streak was left. It was well seen at Bridgwater, and as this was nearer the end point, the "sparks" appeared more brilliant and took the form of small balls of fire given off one after another, until towards extinction, there were, perhaps, four, inclusive of the head, forming a train of white bodies followed by a reddish train or streak, which extended for a distance of about 4° behind the meteor. Mr. T. H. Astbury gives the duration as four seconds, and states that there were five or six fragments dying away one after another.

METEOR OF AUGUST 19, 10^h (local time).

A fine meteor, seen by Rev. T. H. Foulkes from S.S. "Malacca," off Algiers. The meteor was seen on the confines of Aries and Taurus, and was of all colours, chiefly scarlet and orange, not very swift, but with a "powerful" motion. Train short, and general shape like an Indian club. The moment it vanished, close to the horizon a double flash of sheet lightning appeared exactly under the vanishing point of the meteor. As no other flashes were seen during the evening, Mr. Foulkes conjectures that they may have been connected with the meteor, which seems highly probable.

METEOR OF OCTOBER 4, 6.25 (Calcutta time, $5^h\ 53^m$ E.).

Mr. J. W. Meares reports this meteor from his own observation, and also that of others who saw it, and it may be interesting to give the accounts pretty much *in extenso*. Mr. Meares says that "daylight prevented the path being noted properly, but it is "roughly, as follows. Started in R.A., $18^h\ 20^m$, Dec. — 5°, "ended by disappearing behind a house at an altitude about "5° lower. Path nearly 60° in about $3\frac{1}{2}$ seconds, very slow "indeed. Colour dull orange, about 1st mag. at first, increasing "until it had a sensible diameter of nearly $\frac{1}{4}$°, and of a brilliant "white, casting a strong shadow even in the daylight. A train "of sparks was visible some few seconds after disappearance." Mr. H. J. Bell saw it at Chandbali, Orissa (some 160 miles from Mr. Meares' station), and says it seemed to pass almost directly overhead and disappear in the E. A lady in Dacca estimated the time at five or six seconds, and it was travelling S.E. Mr. W. S. Adie, at Berhampore, near Moorshedabad, writes, that it began a little E. of S., and finished a little S. of S.E., travelling horizontally at an altitude of 10°. Among other accounts, Rev. E. G. Roberts, Masulipatam, about 620 miles S.W. from Calcutta, reports that it was seen there, but from its greater distance did not appear brighter than Venus on a dark sky, and was of a vivid blue. These are chiefly of interest to show the long distances over which large meteors are visible, for the details are hardly sufficient to decide on a path for it.

REAL PATHS OF FIREBALLS AND SHOOTING STARS OBSERVED AT TWO OR MORE STATIONS IN 1898. *Contributed by* W. F. DENNING.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1898.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
Jan. 21	5 32	$\frac{1}{2}$=☽	82	25	235	34	Croydon, Surrey	English Channel	133 + 30	*Cancrid*	33 observers.
Feb. 20	8 54	>♀	61	27	95	24	33 miles S. of Beachy Head.	13 miles S.E. of St. Albans Head.	176 + 12	*β Leonid*	18 observers.
April 5	10 15	2×♀	89	25	162	11	25 miles S.E. of Dartmouth.	5 miles N.E. of Bisley.	121 − 1	*Monocerotid.*	5 observers.
„ 16	9 46	3—1½	72	55	52	Slowish	8 miles E. of Nottingham.	7 miles E. of Glossop	212 − 11	*Librid*	A. S. H.; A. K.
„ 16	10 48	Sirius—1¼	60	48	91	24	Halstead, Essex	North Sea	189 − 31	*β Hydrid*	A. S. H.; A. K.
„ 17	9 40	2½—1	85	71	81	41	Stafford	Bridgnorth	261 + 14	*αOphiuchid*	A. S. H.; A. K.
„ 17	9 55	4—3	57	55	24	Slow	Chesham	Bicester	236 − 13	*ψ Scorpid*	A. S. H.; A. K.
„ 17	10 28	5—3	72	70	34	23	Malmesbury	Evesham	176 − 35	*β Hydrid*	A. S. H.; W. F. D.
„ 17	11 12	3—2½	67	44	24	Slow	Stroud	Gloucester	195 + 40	*α Canes Venaticid.*	A. K.; W. F. D.
„ 17	11 28	2	65	61	25	36	Amesbury	Burton	291 + 13	*ε Sagittid*	A. S. H.; A. K.; W. F. D.
„ 18	11 55	2—1½	65	58	19	32	Pontypool	Merthyr	274 + 11	—	A. S. H.; W. F. D.
„ 22	10 30	5—4	72	52	26	Slow	Alcester	Malvern	252 + 49	*β Draconid*	A. K.; W. F. D.
July 16	11 42	2>1	79	37	46	21	Thrapston	Bedford	273 + 76	*ψ Draconid*	A. K.; W. F. D.
„ 26	9 10	½=☽	73	27	191	Slow	25 miles W. of Dieppe.	March, Cambs.	269 − 23	*Sagittarid*	Dennett, Grover, &c.
„ 30	10 43	1—2	81	47	57	36	Northampton	Burford	23 + 53	*Perseid*	A. S. H.; W. F. D.
„ 30	10 53	4—3½	61	52	20	14	Witney	Shipston	311 − 10	*μ Aquarid*	A. S. H.; W. F. D.
„ 30	11 10	3½—3	56	50	28	20	Chipping Norton	Alcester	340 − 18	*δ Aquarid*	A. S. H.; W. F. D.
„ 30	11 35½	3—1	66	52	63	45	Littleport, Cambs.	Blakesley	42 + 23	*ε Arietid*	A. S. H.; W. F. D.
Aug. 11	8 58	2—♀	66	41	196	Slow	River Seine, France	Okehampton	339 − 10	*δ Aquarid*	H. C.; W. F. D., &c.
„ 11	10 15½	2—♀	92	68	45	Swift	Aberdovey	Cardigan	44 + 56	*Perseid*	Five observers.

REAL PATHS OF FIREBALLS AND SHOOTING STARS, &c., 1898—*continued.*

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1898.	h m		Miles.	Miles.	Miles.	Miles.			α° $\delta_\circ$		
Aug. 11	10 26½	2¼—2	86	61	45	58	Shiffnal - -	Leominster - -	46 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	10 46	2½—2¼	79	65	23	46	12 miles W. of Brecon.	Swansea - -	46 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	11 11½	1>1	85	49	57	Swift	Redditch - -	Monmouth - -	44 + 56	*Perseid*	W. E. B.; W. F. D.
„ 11	11 52	2—1½	55	49	53	27	Oakham - -	Chesterfield - -	4 − 20	*β Cetid*	A. K.; W. F. D.
„ 11	11 57	3—2	56	39	25	36	Winchester - -	Fareham - -	57 + 73	*Camelid*	A. S. H.; A. K.
„ 11	12 6½	1	86	46	59	Swift	Kingston - -	Selborne - -	46 + 58	*Perseid*	S. J. J.; T. E. R. P.
„ 11	12 16½	1½—1	74	50	33	Swift	Watlington - -	Hermitage - -	50 + 63	*Perseid*	A. S. H.; W. F. D.
„ 11	12 20	1½—1	64	48	24	37	Cirencester - -	Chipping Sodbury -	54 + 56	*Perseid*	A. S. H.; W. F. D.
„ 11	12 24½	>1—2¼	78	52	36	38	Alton, Hants -	Southampton -	49 + 59	*Perseid*	A. S. H.; W. F. D.
„ 11	12 40	2½—1	85	60	32	31	Chichester - -	Ryde, Isle of Wight	43 + 58	*Perseid*	A. S. H.; W. F. D.
„ 11	12 46½	3—2½	75	59	21	Swift	Oxford - -	Abingdon - -	59 + 63	*Camelid*	A. S. H.; W. F. D.
„ 17	11 43	2—1	71	55	32	43	10 miles N. of Slough	Basingstoke -	72 + 52½	*Aurigid*	A. S. H.; W. F. D.
„ 21	9 16	1½× ♀	60	29	95	19	15 miles S.E. of Cressy, France.	36 miles S. of Brighton.	5 + 13	*γ Pegasid*	A. S. H.; A. R. Schulz.
Sept. 15	8 17	1—2¼	69	61	58	39	Thame, Oxon. -	Salisbury - -	65 + 35	*ε Perseid*	Col. Herschel; W. F. D.
„ 16	10 55½	>2—1	82	55	39	Swift	Devizes - -	Stroud - -	351 + 7	*θ Piscid*	A. K.; W. F. D.
„ 17	11 40¼	1—2¼	95	64	93	—	Strait of Dover -	Woolwich - -	57 + 7	*e Taurid*	A. S. H.; A. K.
„ 17	11 52	4½—1	64	52	19	19	Northampton -	Market Harboro' -	343 ± 0	*β Piscid*	A. S. H.; A. K.
„ 18	8 54	>2¼	69	46	104	Swift	Minehead - -	20 miles S.E. of Falmouth.	84 + 41	*β Aurigid*	T. E. R. P. and others.
„ 22	9 13	3—1	107	82	34	V. slow	Harleston - -	10 miles S.E. of Lowestoft.	254 + 39	*π Herculid*	A. K.; W. F. D.

Abbreviations:—A. S. H., A. S. Herschell, Slough; A. K., A. King, Leicester; W. F. D., W. F. Denning, Bristol.

BRIGHT METEORS OBSERVED DURING 1897.

Date.	Time.	Mag.	Remarks.
1898.	h m s		
Jan. 1 -	12 14 34	Sirius	Beautiful. Appeared at l^2 Virginis, passed 15 Sextantis. Disappeared near ι Hydræ, moderately quick. Duration, 2·9 secs. Faded gradually. Bright streak or train along about 10° of its course at a time.—T. W. B., Arabian Sea.
„ 2 -	11 41 16	Venus	Very beautiful, passed, or directed from $\frac{3}{4}$ (p q) Velæ, towards $\frac{3}{4}$ (δ o) Arg. Disappeared about 4° before that; course about 15°. Quick. When brightest, was bright yellowish green, which was shortly before disappearance. Bright greenish streak.—T. W. B., Arabian Sea.
„ 21 -	5 31 0	½ ☾	(*See* special account,)
„ 26 -	10 6 0	= ☾	(*See* special account.)
Feb. 20 -	8 54 0	> ♀	From 111° + 5° to 97° − 17°. Bluish white, swift.—W. E. B. (*See* special account.)
„ 21 -	9 10 0	> ♀	From 10h. 18m. + 17°·5 to 7h. 18m. + 35°. Duration 3 or 4 secs. Bluish white. Train of 4°.—EVAN REES, Stockton.
Mar. 6 -	10 0 0	4	Passed slowly from 8h. 20m. + 29° to 7h. 42m. + 35°. White, with short train.—EVAN REES, Stockton.
„ 14 -	12 4 0	>1	From 86° + 33½° to 76° + 32° very slow.
Apr. 5 -	10 15 0	♀	(*See* special account.)
„ 19 -	10 50 0	4	From 252° + 23° to 242° + 19°. Slow. Colour, bluish white.—E. R. B.
July 14 -	8 16 0	> ♀	From near ϵ Delphini towards lower part of Pegasus, passing out of sight behind building. 10° of path seen. Very slow. Colour yellowish white, no train.—R. J. RYLE, M.D., Brighton.
„ 29 -	12 10 0	> 4	From 346° + 5° to 333° − 6°. Slow. Orange yellow. Near limit of vision.—E. R. B.
„ 31 -	10 21 0	4	About 30° S.E. of Moon, directed from Altair. Red. Short train.—H. J. T., Paignton.
„ 30 -	10 43 0	4	From 15° + 54° to 4° + 54½°. Very slow. Streak, near its radiant, an early Perseid.—W. F. D.
Aug. 3 -	9 58 0	4	From 15° + 43° to 25° + 22°. Duration 1 sec. Red streak.—H. J. T., Paignton.
„ 3 -	10 38 0	Capella	From 51° + 51° to 57° + 48°. Duration 1 sec. Blue streak.—H. J. T.
„ 6 -	10 30 0	4	From 307° + 13° to 299° − 1°. Burst out as a flash of light. Duration 1 sec.—H. J. T.
„ 8 -	9 41 0	>1	From 355° + 46° to 334° + 30°. Swift. Streak.—W. E. B., Exeter.
„ 9 -	9 37 0	4	Directed from δ Ursæ Majoris, towards ¼° s.p. η Bootis, disappeared 1° before that. Course seen 6°. Very quick, 3 secs. Streak or train.—T. W. B.
„ 10 -	10 36 0	Sirius	From 328° + 60° to 302° + 46°. Swift, streak.—H. C.
„ 10 -	10 40 0	4	From 333° + 35° to 315° + 10°. Long streak, flash at end, leaving spot for some seconds.—H. C.
„ 10 -	10 41 0	Bright	From 325° + 67° to 279½° + 42°.—T. E. R. P.
„ 10 -	10 43 0	>1	From 246° + 62° to 242° + 46°. Quick, streak.—H. C.
„ 10 -	10 50 0	4	Directed from 2 (γ η) Persei towards α Andromedæ, disappeared about Dec. + 45°. Course, 6° or 7°. Moderate speed.—T. W. B.

Date.	Time.	Mag.	Remarks.
1898.	h m s		
Aug. 10 -	10 50 2	Sirius	Directed from α Pegasi, disappeared about $\frac{2}{5}$ (γ Pegasi, α Andromedæ). Course 10°. Moderate.—T. W. B.
„ 10 -	10 51 0	>1	From 75° + 63° to 80° + 63°. Yellow. Swift, streak.—H. C.
„ 10 -	11 25 0?	>1	From 360° + 18° to 349° + 2°. Orange. Streak.—H. C.
„ 10 -	11 59 0	Bright	From 343° + 28° to 330° + 83°.—T. E. R. P.
„ 10 -	12 0 0	4	From 30° + 69° to 20° + 73°. Bright flash and streak.—H. C.
„ 10 -	12 1 30	4	From near γ Cephei to a point below Polaris. Greenish.—S. J. J.
„ 10 -	12 2 0	4?	From 35½° + 65° to 215° + 77°. Large, bright.—T. E. R. P.
„ 10 -	12 5 0	Bright	From 187½° + 54° to 177½° + 46°. Green.—T. E. R. P.
„ 10 -	12 5 0	>1	From 247° + 43° to 247° + 30°. Fine. Orange, streak.—H. C.
„ 10 -	12 6 0	1	From a point 1° N. of β Persei to 8° towards S.W.—S. J. J.
„ 10 -	12 6 0	—	From 11¼° + 28° to 354¼° + 12°.—T. E. R. P.
„ 10 -	12 7 0	—	From 38¼° + 47° to 32½° + 32°.—T. E. R. P.
„ 10 -	12 8 0?	>1	From 290° + 52° to 275° + 38°. Orange. Streak.—H. C.
„ 10 -	12 24 0	Bright	From 60° + 60½° to 72° + 62°.—T. E. R. P.
„ 10 -	12 52 0	Bright	From 334½° + 70° to 265° + 55½°.—T. E. R. P.
„ 11 -	8 58 0	>♀	(*See* special account.)
„ 11 -	9 18 0	>1	From 353° + 38° to 343° + 27°. Red. Swift. Streak.—H. C.
„ 11 -	9 19 0	2×♀	From 95° + 70° to 157° + 59°. Very fine. Blue flash and streak.—H. J. T., Paignton.
„ 11 -	10 1 30	♀	From 5° E. of γ Ursæ Majoris passed over χ and disappeared 1° further.—S. J. J.
„ 11 -	10 14 0	4	Directed from near ϕ^2 Andromedæ and γ Persei. Dispeared near β Andromedæ. Slowish from nearness to radiant.—T. W. B., Seaton Carew.
„ 11 -	10 15 0	♀	From 140° + 72½° to 165° + 64°. Swift, streak.—W. E. B., Exeter.
„ 11 -	10 16 0	4	From 200° + 61½° to 206° + 44½°. Rapid with streak and flash. Perseid.—W. F. D.
„ 11 -	10 17 0	Very bright.	From 160° + 71° to 189½° + 45½°.—T. E. R. P.
„ 11 -	10 17 0	Sirius	From 165° + 73° to 184° + 54°. Yellow. Swift. Streak.—H. C.
„ 11 -	10 17 15	1	Commenced ½° above α Ursa Majoris, vanishing at γ.—S. J. J.
„ 11 -	10 32 30	Sirius	From 342° + 40° to 345° + 13°. Swift. White, not α Perseid.—E. R. B.
„ 11 -	10 34 0	Arcturus	From 98° + 56° to 117° + 51°. Wavy path. Red streak.—H. J. T.
„ 11 -	10 34 15	1	From ψ Ursæ, and travelled 12° diagonally towards W. horizon.—S. J. J.
„ 11 -	10 45 0	4	From 240½° + 62½° to 237° + 47°. Very rapid. Streak. Perseid.—W. F. D.
„ 11 -	10 48 30	>1	From 52° + 55° to 55° + 53°. Swift. Streak.—W. E. B.

Date.	Time.	Mag.	Remarks.
1898.	h m s		
Aug. 11 -	10 57 0	>1	From 21°+26° to 16°+11½°. Rapid. Streak. Perseid. —W. F. D.
„ 11 -	11 27 0	Bright	From 328½° + 65¼° to 276¼° + 34¼°.—T. E. R. P.
„ 11 -	11 31 15	>♃	From 343° + 51° to 323° + 41°. Swift. Golden, flashing at end and perhaps deflected.—E. R. B.
„ 11 -	11 50 0	Sirius	From 187° + 53° to 200° + 71°. Swift. Streak.—H. C.
„ 11 -	11 58 0	1	From 6° + 23° to 359° + 10°. Orange. Streak.—H. C.
„ 11 -	12 1 0	Sirius	From 17°+69° to 347°+71°. Slowish. Orange. Bright streak. ? Camelid.—E. R. B.
„ 11 -	12 23 0	Sirius	From 37° + 14° to 37° + 7°. Swift. White.—E. R. B.
„ 11 -	12 23 30	♃	From 14½°+ 29° to 6° + 16°. Rapid. Flash. Streak. Perseid.—W. F. D.
„ 11 -	12 24 0	♀	From 57½° + 55° to 67° + 50°. Swift. Bluish. Streak. —W. E. B.
„ 11 -	12 24 0	1	From 185°+73° to 195°+62°.—H. C.
„ 11 -	12 25 0	Sirius	From 331°+32° to 331½°+ 39°. Swift. White. Golden streak.—E. R. B.
„ 11 -	12 27 0	1	From 40° + 62½° to 37° + 66°. Orange. Narrow green streak, near radiant. H. C.
„ 11 -	13 2 0	♃	From 350° + 76° to 380° + 73°. Very swift. White.— E. R. B.
„ 11 -	13 11 0	♃	From 20½° + 1° to 18° + 11°. Rapid, flash, streak. Perseid.—W. F. D.
Sept. 3 -	7 3 0	2×♀	Seen in twilight and path estimated from 6° + 53° to 32° + 58°. Slow. 2 secs. White, no train.— T. H. ASTBURY, Wallingford.
„ 15 -	8 18 0	♃	From 11° + 39° to 333° + 26°. Slowish, bright streak. Radiant, 61° + 36°.—W. F. D.
„ 15 -	8 56 0	Sirius	From 17h. 30m. + 40° to 17h. 10m. + 17°. Quick. 2 secs. Yellow, with narrow streak. — J. M. WADMORE, Exmouth.
Oct. 3 -	6 15 0	♀	From about 40° above S. horizon, fell 15° towards S.W. —G. T. DAVIS, Reading.
„ 18 -	13 24 0	♀	From 87° − 1° to 105° − 10°. Bluish white. Swift. Arietid.—W. E. B.
„ 31 -	8 50 45	♃	Burst out 15° S.W. of γ Arietis, increased in brightness and vanished 10° beneath γ Pegasi.—S. J. J.
Nov. 6 -	10 24 30	♃	From 40 Ceti, passed between η and θ Ceti; also 7° E. of β and proceeded 1° further, momentary train.— S. J. J.
„ 13 -	15 26 0	Sirius	From 179° + 22° to 185½° + 21½°. Duration ·7 sec. Bluish, appeared to explode. Leonid.—J. H. B.
Dec. 12 -	12 29 0	♀	Magnificent, various colours, for the last 3° or 4° green with red train. Geminid, passed π^6 Orionis and o^3 Eridani, going 2° or 3° further. Course about 20°. Quick. Duration 2·3 secs.—T. W. B.
„ 12 -	14 23 30	♃	From 106½° + 16½° to 107½° + 7°. Geminid. Quick, small round head.—W. E. B.

Observers—E. R. BLAKELEY, Dewsbury.
T. W. BACKHOUSE, Sunderland.
W. E. BESLEY, Westminster.
W. F. DENNING, Bristol.
H. CORDER, Bridgwater.
REV. S. J. JOHNSON, Melplash, Bridport.
REV. T. E. R. PHILLIPS, Hendford, Yeovil.
H. J. TOWNSHEND, Leeds.
Place of observation as above, unless otherwise stated.

Report on the Auroral Displays of 1898.

As it is only recently that the suggestion was made for Members to report auroral observations to the Director of the Meteoric Section, not very much has been done to get together details of last year's displays. The report will be therefore, a short one, and also for the reason that at this time of scarcity of sun-spots, Auroræ are also infrequent. The one fine display of September 9 has already been described at some length in the "Journal," so that a brief record of it here from several observers is all that will be needed.

Many observers, especially those living near towns, where the sky is often more or less illuminated, would doubtless hesitate to record as an aurora a mere faint light in the northern sky, and, of course, towards the summer it becomes increasingly difficult to differentiate them from the zodiacal light, the Milky Way, and twilight.

In the winter it is more easy, and it will be found an interesting plan always to examine such glows with a spectroscope, when the greenish auroral line will very often decide the point, although sometimes it may be too faint for small instruments.

In the future it will be advisable for observers in reporting to the Director, to describe what form the display takes, whether it consists only in a faint glow, whether a distinct arch of light is seen, or streamers appear, or lastly, whether the corona is formed overhead, with the various accompaniments of a really great display. Careful note should be made of the time and position or path of any shifting patches or broken arches of light or specially brilliant streamers.

In the early months of 1898, no auroras seem to have been recorded, but in April some were seen in Scotland, and on April 12, there was a display reported by Mr. Forsyth, at Macduff, N.B., as "fairly extensive, but not bright." At Bridgwater, it was not seen until about 9.10, when a bright glow was noticed along the northern horizon, with sheaves of pale streamers. At 9.20, there was a rather brilliant patch of light in the N.E., which travelled slowly to the N., when it threw up some long streamers, one resembling a curved comet's tail, probably from a secondary streamer forming by the side of the upper part of it. After 9.30, the display waned.

GREAT AURORA OF SEPTEMBER 9.

Several reports of this phenomenon have already been published; to which may be added a note by Mr. J. H. Astbury, of Wallingford, on the Arch of Patches of Light in the S., which he had described in the "Journal" (Vol. IX., p. 25). When first seen, these clouds were just to the S. of θ Aquilæ, and it was curious to note "the manner in which the patches moved across the sky. "They did not simply move as clouds, but the leading (eastern) "end of the patches extended by a very rapid succession of tiny "tongues of light, which appeared to leap over each other from "the end of the patch in a way which I can only compare with "the strong ebullition of molten metal. There was little, if any, "contraction at this end, but at the western end the extension

" and contraction were both very strongly marked, and were of " the whole width of the patches. The width remained nearly " constant throughout their course, though it varied in the " different patches. I did not see anything of the southern " display after about 8.25, by which time it had descended to the " horizon."

Mr. J. E. Clark, of South Croydon, notes that the display, especially the southern arch, was like a shifting search light. At 9.30, there were streamers W. of magnetic N., with a very distinct spectrum. Earlier in the evening some were tinted with red. At 11 o'clock, the lower edge of the arch was sharply defined. At mag. N., the altitude of the top above the horizon was twice the distance between $\alpha - \beta$ Ursæ Maj., and was distant in azimuth, once the distance between $\alpha - \beta$, W. from N.

Rev. S. J. Johnson reports the display as brilliant: " At 9.20, " as a considerable illumination over a fourth of the horizon from " Arcturus due W., to a point due N., being especially bright " beneath α and β Ursæ Maj. Two streamers, one stretching " beyond β and γ Ursæ Minoris, the other across δ and ϵ. A few " faint streamers after this. At 9.50, the illumination contrasted " strongly with some small black clouds above the W.N.W. " horizon. About 10.5, a deeper yellow colour was noted. At " 10.20, the aurora had faded, but at 11.30, it was again present " with bright low streamer in the N.W."

The Director observed from Clifton Down, and at first, soon after dark a bright display was noticed, somewhat tinged with red, but clouds came over, and hid it for some time. At 10.30, it was brilliantly clear, with a green arch along the N.W. horizon, and occasional streamers through the Great Bear. At 9.50, especially, there were four or five, one being very narrow and sharp. All were to the W. of the Pole Star, and moving slowly from E. to W. Bright light extended some distance E. of N., but the whole display was centred far to the W. of that point.

About midnight, it was still very clear, and the auroral light very beautiful, with brighter streamers, but I do not think I saw any form W. of the Pole Star at any time.

At Bridgwater, no other displays than these were recorded during the whole year.

At the time of the April aurora, sun-spots were very scarce, but as will be remembered there was an extremely fine one at the time of the September display, " the spot having crossed the central " meridian of the sun about 14 hours before the magnetic dis- " turbance set in, which was at its height from 8 to 11 o'clock on " Friday, September 9," as described by Mr. Maunder.

Errata.

In Report for 1897, page 5, in Remarks on April, *for* " Leonids " *read* " Lyrids." Page 10, Meteor of August 4, the time *should read* " 10.33, and the meteor passed $\frac{1}{2}°$ 'left' of κ Cephei," *not* " East."

SECTION FOR THE OBSERVATION

OF

THE SUN.

DIRECTOR.—REV. A. L. CORTIE, S.J., F.R.A.S.

EIGHTH REPORT OF THE SECTION, 1898.

Introduction.

The present Report is mainly due to the energy and devoted industry of Miss Brown, the late Director of the Section. Almost the whole of the sheets for the Calendar and for the Ledger had been drawn up at the time of her death. The work of the present Director has been chiefly confined to a careful revision of the manuscript. In this work the proof sheets for 1898, of the invaluable series of Greenwich measures of the positions and areas of sun-spots, courteously supplied by Mr. Maunder, and the series of Stonyhurst drawings of the solar surface, have been of very great assistance. By this means the comparatively few gaps in the continuity of the record for the year which existed have been filled up.

The total number of groups recorded in 1898 was only 91, and the days on which no spots were seen amounted to 38. The following table, prepared by aid of the reports so far published, exhibits the rise and fall in the number of groups observed each year, and the corresponding decrease and increase of the days on which no spots were seen on the visible solar disk during the last eight years. It will be noted that the rise to the maximum number of groups in the year 1893, from the year 1891, was somewhat more rapid than the decline from 1893 to 1897. The

fourth column in the table gives the number of days each year on which no record appear in the reports:—

Year.	Groups.	Number of Days of no Spots.	Days of no Record.
1891 - -	130	16	0
1892 - -	224	0	44
1893 - -	285	0	22
1894 - -	279	0	27
1895 - -	234	0	33
1896 - -	161	3	18
1897 - -	130	21	31
1898 - -	91	38	0

The records for the year 1891 were filled up by the aid of the Greenwich volume, as stated in the Report for that year. During the period from March 28, 1891, to April 14, 1896, or for more than five years, the observations published in these reports show that there was no day on which the sun was free from spots.

Of the 91 groups observed during the year 1898, at least two-thirds were composed of small or insignificant spots. Fifteen of the groups belonged to six separate disturbances, and five more of moderate area (groups 55, 56, 57, 59, 60) crossed the disk in the last days of July and the first half of August. The longest period without any spots was the 13 days, July 2–14. But one group, that which reached its greatest development in the month of September, was not only remarkable in itself for its great size, but still more, in that it appeared at a period in the cycle of solar activity, when the minimum was fast approaching. In area, when at its greatest phase (2235 millionths of the visible hemisphere), it did not fall far behind any of the largest spots of the last two maxima. It is noteworthy, too, that the previous year, 1897, at least three years after the maximum, was marked by the enormous group of the month of January, probably the greatest recorded during the last two cycles. It is a well-established fact that the descending arms of the curves of solar activity are much less steep than the ascending arms. Is it also true that the years of decline are marked by these occasional great outbursts of the seemingly pent-up solar energies before their final subsidence? The point is worth inquiring into.

The particular group under discussion crossed the visible disk four times, being first seen on August 11, and last seen on November 7. Its history is given in the "Ledger" under the numbers 61, 66, 73, and 79. It is illustrated by a beautiful drawing by Mons. Antoniadi, published in the "Journal," Vol. IX., No. 12, page 70, and it has been considered sufficiently important and interesting to receive further illustrations of its appearance, during its second and third passage across the disk, from sketches by Mr. Corder, Mr. Astbury, and Prof. Pereira. During its first appearance (group 61) it consisted of a few insignificant dots, and

its last appearance (group 79) was of a precisely similar character. Magnificent faculæ of great extent clustered thickly round it when it reached the W. limit of the sun on October 12, at the end of its second transit of the visible disk. Prof. Pereira's drawing of October 6 shows the "black holes" in the umbra, as also a bright bridge very conspicuously. We cannot, however, subscribe to his opinion, expressed in his note, that these conjoined phenomena are conclusive against a possible elevation of the spot on the solar surface.

Great industry has been displayed by the observers of the Section in noting the first beginnings of an outburst of spots, especially by Mr. Bartlett, and by Mr. Hadden, who has supplied a very complete catalogue and description of nearly all the groups recorded. From these observations about six cases were found which could be utilised in studying the connection between the faculæ and the first beginnings of a spot disturbance, a subject to which the present Director called particular attention in a paper printed in the "Journal," Vol. IX., No. 3, and which can be more easily studied at the minimum than at the maximum period of solar activity. Up to the present time Father Sidgreaves, from a careful study of a selection of the Stonyhurst series of drawings, has found six cases in which faculæ certainly preceded the first beginnings of the spot group and three other probable cases. From the materials I have been able to discuss, I have found one more certain case. It occurred in the group which crossed the disk in the first days of November, and which died on the visible hemisphere during its second passage on December 2. The following table in which a summary of its life history is given will enable observers to study the matter for themselves from the Greenwich publication, and from our Report.

Group B.A.A.	Number Greenwich.	Max. Area.	Mean Heliographic.		Central.	First seen.	Last seen.
			Long.	Lat.			
80	4807	680	206	+6	Nov. 5	Oct. 31	Dec. 2
85	4816	30	211	+5	Dec. 1		

The observations are as follows:—On October 30 two small compact bright patches of faculæ were drawn at Stonyhurst at the E. limb of the sun at 11.50 a.m., in the position longitude 199° and latitude from +5° to +8°. They had all the characteristic appearance of new faculæ; and, moreover, no disturbance of the solar surface by either spot or faculæ had been recorded in this region (as a study of the positions in the Greenwich volume shows) since August 11, when a group of faculæ was measured at longitude 200·7° and latitude +12·5°; that is, during a period of about three solar rotations. The Greenwich photograph, one of the Indian series, taken at $7^h\ 38^m$ a.m., does not record the faculæ. No drawing was made at Stonyhurst on

October 31; at $8^h\ 10^m$ a.m., Miss Brown observed and saw no spots, but at $9^h\ 15^m$ Mr. Bartlett saw a few hardly perceptible spots near the E. limb. They were probably too faint to be shown on the photograph taken at Greenwich at $12^h\ 40^m$, for they are not recorded, but the position of the faculæ is given at longitude 203·3° and latitude +8·1°. The next day, November 1, the spot group was photographed at Greenwich, at mean position longitude 202·1° and latitude +8·3°. This evidence of the connection of spot-group and faculæ is corroborated by the Stonyhurst drawing of the same date. During the second rotation the group consisted of a few small spots.

NAMES of MEMBERS of the Section.

Name.	Address.	Instrument.	——
ASTBURY, J. H.	Wallingford	3¼-in. O.G.	Drawings (projection).
BARTLETT, J.	Bramley	4-in. O.G.	„ „
BELL, J. E.	Sydney, N.S.W.	„	„ „
CORDER, H.	Bridgwater	6½-in. Spec.	„ „
CORTIE, Rev. A. L.	Stonyhurst	15-in. O.G.	Drawings, measurements of position.
ELD, The Rev. F. J.	Polstead Rectory.	8¾-in. Spec.	Measurements of position. Tracings.
HADDEN, DAVID E.	Alta, Iowa, U.S.A.	4-in. O.G.	Daily record.
PEREIRA, J. DE MORAES.	Azores	4½-in. O.G.	Drawings and measurements of position.
SIMPSON, DAVID G.	Denmark Hill, London.	„	Drawings (projection).
SMART, Dr. D.	London	10-in. Spec.	Photographs and measurements of position.
SOLÁ, JOSÉ COMAS	Gerona, Spain	—	——
TOWNSEND, J. S.	Sevenoaks	4½-in. O.G.	Photographs, diagrams, and measurements of position.
WADMORE, J. M.	Exmouth	3-in. O.G.	Direct vision.
WAUGH, The Rev. W. R.	Portland	4½-in. O.G.	Drawings (direct vision).
WHICHELLO, Dr. H.	Chester	„	Drawings (projection).

Calendar of Sun-spots and Faculæ.

JANUARY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	1, 2	(A few small spots near W. limb at 8.30 p.m seen by Mr. Hadden. No. 129 of December 1897.)
2	1, 2, 3, 4	W. 5° to 15° N. One patch to the S. f. group 129 of December 1897?
3	1, 2, 3, 4	E. numerous, region of 4. Not observed on the 2nd.
4	1, 2, 4	E. region of 4.
5	1, 2, 4	E. region of 4, W. position of 1.
6	1, 2, 4	E. still visible round 4. W. position of 1.
7	1, 2, 4	E. a little S. of equator, faint but numerous. W. chiefly to the N. of 1.
8	2, 4	W. 14° to 17° S.
9	2, 4	W. region of 2.
10	2, 4	W. same latitude.
11	4	W., S. of equator, some distance from limb.
12	4	W.
13	4, 5	(Two dots near E. limb, possibly belonging to group 6.)
14	4, 5	E. conspicuous, S. f. 5.
15	5, 6	E. round group 5, especially the f. spot.
16	5, 6, 8	E. region of group 8.
17	5, 6, 8	Central 5, following 8.
18	5, 6, 7, 8	E. central 8.
19	5, 6, 7, 8, 9.	
20	5, 6, 7, 8, 9.	
21	5, 6, 7, 8, 9.	
22	5, 6, 7, 8, 9	F. numerous, half-way between 9 and limb. W. round 6 and 7.
23	5, 6, 7, 8, 9	E. 3° to 15° S.
24	5, 7, 8, 9	E., W. central 7, following 5.
25	5, 8, 9	E. following 5.
26	8, 9.	
27	9.	
28	9.	
29	9.	
30	9	W. (a bright ridge extending along 9 on the W. side).
31	9	W. extensive 5° N. (position of 9). Slight on E.

FEBRUARY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	No spots.	
2	No spots.	
3	No spots.	
4	10, 11.	
5	10, 11	E. numerous, region of 11, one patch far from limb. Central 10.
6	10, 11	E. numerous, about 11 and following.
7	10, 11, 12 13	E. 2° to 9° S. Position of 13 and a patch to the N.
8	10, 11, 12, 13	E. region of 13. W. region of 12.
9	10, 11, 12, 13, 14	(A small spot S. f. 10, about 20°, not numbered.) E., especially N. of 13 and 14. W., S. p. 12.
10	10, 11, 13, 14	E. 5° to 16° S. W. 17° to 30° N.
11	10, 13, 14	E. f. 14 W. Same position as on the 10th.
12	10, 13, 14, 14A	E. Two dots in faculæ. W. 0° to 16° S.
13	13, 14	E. on a line with group 14, but far behind. W. bright, same position as 12th.
14	13, 14	E., same as on the 13th. W., a patch to the S. far from limb.
15	13, 14, 15, 16, 17	E. 0° to 15° N. 0° to 5° S.
16	13, 14, 15, 16, 17	E. 0° to 10° N. around 16 S.
17	13, 14, 14B, 15, 16, 17, 18, 19.	
18	13, 14, 14B, 16, 17, 18, 19.	
19	13, 14, 16, 17, 18, 19.	
20	14, 17, 18, 19	W. region of 14. Numerous.
21	17, 18, 19	Bright patch W. N. of place of 14.
22	17, 19, 20	E. round 20.
23	17, 19, 20	E. region of 20, and some distance to the N. Round 17 and 19. Compact.
24	17, 19, 20	E. region of 8 to N. of 20. Branching round 17 and 19.
25	17, 19, 20	W. 0° to 15° N. 0° to 7° S.
26	17, 19, 20	W. 0° to 12° N. 0° to 5° S.
27	20, 21.	
28	20, 21	E. 0° to 15° S. Also two separate patches more N.

MARCH 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	20, 21	E. 2° to 14° S. Compact about the spot 20.
2	20, 21	E. f. group 21, numerous. Compact about 20.
3	20, 21, 22, 23	E. 8° to 15° S.
4	20, 21, 24	E. region of 24. W. one patch, lat. of 22.
5	20, 21, 24, 25, 26	W. round and S. of 20.
6	21, 24, 25, 26, 27.	
7	21, 24, 25, 26, 27	E. region of 25, 26, 27. Especially bright N. of 27. Position of February train.
8	21, 24, 24A, 25, 26, 27	E. f. 27. Two or three small spots near W. limb in S. lat. ; also on the 9th.
9	21, 24, 24A, 25, 26, 27.	
10	21, 24, 24A, 25, 26, 27	E. faint, f. 26 and 27. W., S. f. 21.
11	21, 25, 26, 27	W. region of 21.
12	25, 26, 27	W. on a line with 25.
13	25, 26, 27	E. extensive (a dot in N. lat.). Faint spots near centre of disk observed only by Mr. Hadden, also 14th and 15th.
14	25, 26, 27.	
15	25, 26, 27	W. round 25, 26, 27.
16	25, 26, 27, 27A	E. conspicuous round 27A.
17	25, 27, 27A, 27B	W. region of 25. A few in N. lat. region of 26.
18	27.	
19	No spots	(Two dots near centre of disk, seen only by Mr. Hadden.)
20	No spots	W. small patch near limb.
21	28. 29?	Groups 28 and 29. Probably those seen by Mr. Hadden. Greenwich and Stonyhurst no spots.
22	28, 29	(One small spot W. about 17° S. lat.) Not in Greenwich series.
23	No spots.	
24	No spots	E. far from limb. W. one patch far from limb.
25	30	E. round 30. W. slight faint patch.
26	30.	
27	30.	
28	30	E. limb extensive.
29	30	E. 7° to 20° S. Some far from limb.
30	No spots.	
31	31, 32	E. p. 32.

APRIL 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	31, 32	E. 3° to 20° S. extensive.
2	32	E. 0° to 23° S.
3	32	E. 0° to 26° S.
4	32	E. 0° to 4° N. 0° to 25° S. Very extensive from 32 to E. limb.
5	32	E. 12° S., W. 5° to 10° S., and 15° S. Conspicuous far from limb.
6	32.	
7	32	Small patch E. limb.
8	32, 33	W. 10° to 12° S.
9	32, 33.	
10	32, 33	W. p. and surrounding group 32.
11	32, 33	W. round 32 extensive.
12	32, 33	W. region of 32. Beautiful branches.
13	32, 33	W. round 32, and far to the S. Also around 33.
14	No spots.	
15	No spots	W. position of 32.
16	No spots.	
17	No. spots,	
18	No spots.	
19	No spots	E. two patches. W. one patch
20	No spots.	
21	No spots	E., a small patch to the N. W. further from limb.
22	34	E. 20° or more S. W. 10° S
23	34	E. region of 34.
24	34	E. round and f. 34.
25	34, 34A.	
26	34A, 34B	E. region of 34B.
27	34A, 34B	E. extensive near limb.
28	34A, 34B	E. with a small spot f. 34B.
29	34A, 34B	Region of 34A.
30		A few small spots.

MAY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	- - - - -	Three spots, Stonyhurst, near W. limb. Greenwich group 4722.
2	34, 34A, 35.	
3	35 - - - -	E. near limb. W. near limb.
4	35.	
5	35, 37 - - - -	E. conspicuous around 37. W. far from limb to the S.
6	35, 35A, 36, 36A, 37, 38 - - -	E. a ring over penumbra f. 38 W. far from limb S.?
	35, 35A, 36, 36A, 37, 38 - -	E. f. 38. W. near limb. S.?
8	36, 36A, 37, 38 - - -	Only observed by J. Comas Solá.
9	36, 36A, 37, 38.	
10	36, 36A, 38.	
11	36, 38.	
12	36, 38 - - - -	Bright dot E. Stonyhurst, W. Greenwich and Stonyhurst.
13	38, 39 - - - -	E. around 39.
14	38, 39.	
15	38, 39 - - - - -	W. numerous f. 38.
16	38, 39, 40.	
17	38, 40.	
18	38, 40, 41 - - - -	E. 9° to 20° S.; f. 40, and in a ring to the N. of it. W. 3° to 13° S., region of 38.
19	40.	
20	40 - - - -	E. numerous, with a dot a little N.
21	40 - - - - -	Many scattered near W. limb.
22	40, 40A - - - - -	W. far from limb to the S.
23	40, 40A - - - -	W. far from limb, N.? Large atch near E. limb.
24	40, 40A - - - -	E. and W.
25	40, 40A - - -	A small spot near E. limb in N. lat.; seen also on the 26th by Mr. Hadden.
26	40, 40A - - - -	Very bright compact masses about 40. E.
27	40A - - -	W. region of 40 inconspicuous. E many faint patches.
28	40A, 42 - - - -	Faint patches E. and W
29	40A.	
30	43, 44.	
31	43, 4.	

JUNE 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	43, 43A, 44	
2	43, 43A	A few dots not numbered in long. 101° lat. 6° N. Seen also on the 3rd.
3	43, 43A	W. region of group 43.
4	43A.	
5	43A, 45	E. with a dot near limb; also seen on the 6th.
6	43A, 45.	
7	43A, 46	W. bright round 43A, and a patch f. 46 E.
8	No spots	W. bright patch. Penumbral patch.
9	No spots	Magnificent faculæ W. Fainter patches E.
10	No spots.	W. Three minute spots near central meridian.
11	No spots	W. A pair of very small spots.
12	No spots	(A tiny pair not numbered near central meridian.)
13	47.	
14	47.	
15	47	E. near limb at 5.30 p.m. S.?
16	47, 48.	
17	47, 48	W. region of 47, bright and numerous.
18	47, 48	W. same lat. 10° to 20° N. Central to 48.
19	48	E. very extensive, lat. of 49. Bright patch W.
20	48, 49	E. region of 49, especially S. of it.
21	49.	
22	49	E., a patch at some distance from limb. Several scattered faint patches.
23	49	E., a few near equator. W. with a small spot not numbered.
24	49.	
25	49, 50, 51	W. bright to the N. and a narrow stream to the S. A small spot near central meridian at 6.15 p.m.
26	49, 50, 51	E. round 51.
27	49, 50, 51, 52.	
28	49, 51, 52	Surrounding the groups.
29	49, 51, 52	W., S. f. 49 extensive.
30	51.	

JULY 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	51	W. latitude of 49°.
2	No spots	W.
3	No spots.	
4	No spots	E. extensive. N. Faint W.
5	No spots	E. 10° to 15° N. Long. about 269° to 257°. W. 4° to 14° S.
6	No spots	W. same lat., but nearer limb.
7	No spots	E. about 17° S. W. 0° to 14° S.
8	No spots	E. same lat. as on the 7th, further from limb.
9	No spots	Faint patches E. and W.
10	No spots	Faint patch W.
11	No spots	E., a few near limb.
12	No spots	E., very few.
13	No spots	A bright isolated patch 20° from W. limb.
14	No spots	W. faint.
15	53	W. same latitude.
16	53.	
17	53	E. to the S. Some far from limb. W. one bright patch N.
18	No spots	E. few, one patch bright. W. same lat. as on the 17th.
19	54.	
20	54	W. faint. Bright, compact about spot group.
21	54.	
22	54.	
23	54	E. to the S. Some far from limb.
24	54	E. 20° to 24° S.
25	56	E. with three very small spots. Position of faculæ on the 24th.
26	No spots	Few unstable evanescent spots.
27	No spots	W. about 3° N.
28	No spots	Few very small unstable spots.
29	55, 56.	
30	55, 56	E. region of 57 and p. W. about 10° S.
31	55, 56, 57	E. round 57 and to the S.

AUGUST 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	55, 56, 57, 58.	
2	55, 56, 57, 58, 59	E. region of 59. W. probably latitude of 55.
3	56, 57, 59.	
4	56, 57, 59	W. 5° to 10° S., far from limb. Surrounding 59.
5	56, 57, 59	W. region of 56.
6	57, 59.	
7	57, 59	W. extensive. Position of 56.
8	57, 59	W. same locality, nearer limb.
9	57, 59	Central to 57. Few faint patches W.
10	57, 59.	
11	57, 59, 60, 61	W. around and f. 57.
12	59, 60, 61	W. f. 59. S.W. region of 59.
13	59, 60, 61.	
14	60, 61	W. one patch near limb f. 59. E. limb to the S., with a small spot at 8.30 p.m. (Iowa) in N. lat.
15	60, 61	E. with two very small spots where faculæ appeared on the 14th.
16	60, 61	E. far from limb; seen also on the 16th and 17th.
17	60, 61	W. p. 61, and around 60
18	60, 61	W. bright, position of 61. Mr. Bartlett reports a dense mass to the N. of 60.
19	60	W. region of and S. of 60.
20	No spots	E. small, near limb.
21	62.	
22	62, 63	W. 13°. S.
23	62, 63	Central.
24	63	W. round and far S. of 63.
25	No spots	W. bright, position of 63 and a patch to the S. further from limb.
26	64, 65.	
27	64, 65	E. round and f. 65.
28	64, 65	E. circular patches f. 65.
29	65	E. extensive to the S. Two small spots a little E. of meridian in S. lat.
30	65	E. 10° to 22° S.; far from limb.
31	65	E. 10° to 30° S; extensive, far from limb. W. bright patch to the N., and one about 7° S.

SEPTEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	65	E. rather faint; position of 66? W. a few round small spots near limb.
2	65, 66.	
3	65, 66	E. 10° to 20° S.
4	65, 66	E. 7° to 24° S. A large mass between large spot and limb. Mr. Wadmore reports them as being very complicated.
5	65, 66	E. 6° to 20° S. W. preceding 65 for most part.
6	65, 66	E. f. group 66.
7	65, 66	W. f. 65.
8	66	Near W. limb, faint.
9	66	W. limb. N.?
10	66	E. 8° S.
11	66, 67.	
12	66, 67.	
13	66, 67	W. 10° to 31° S.
14	66, 67, 68	W. 10° to 25° S.
15	66, 67, 68, 69	W. 8° to 22° S. Conspicuous.
16	67, 68, 69	E. and bright patch round spot.
17	67, 68, 69.	
18	67, 69.	
19	67, 69	W. bright, f. 68. Round 67.
20	69	W. 4° to 18° N.
21	69	E. close to limb. Small but bright.
22	69	E. very bright, 0° to 6° N. Nearly position of 65.
23	69, 70	E. 14° N. and 0° to 10° N.
24	69, 70	W. region of 69.
25	70?	W. f. 69.
26	70?, 71	E. 10° to 20° S. (small flaky). N. region of 71.
27	70?, 71	E. two very bright patches to the S.
28	70?, 71, 72	E. round and N. of 72.
29	71, 72	E. 6° to 13° S. bright, p. 73.
30	71, 72, 73	E. f. 72 and region of 73. (Large group returned.)

OCTOBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	71, 72, 73	E. 0° to 20° S. (Return of large spot.)
2	71, 72, 73	E. 0° to 25° S. W. 0° to 10° N.; 0° to 9° S.
3	71, 72, 73	E. scattered patches, f. 73.
4	71, 72, 73, 74	Surrounding 71, f. 73.
5	72, 73, 74.	
6	72, 73, 74	E. 5° to 7° N. W. 10° to 14° N.
7	72, 73, 75.	
8	72, 73, 75	W. 20° N. Central 75.
9	72, 73, 75	E. 15° to 20° S. Central compact, 73; f. 75. W.
10	73, 75	E. Central, compact 73. Extensive W.
11	73, 75	W. limb large masses c. and f. 73, Central 75. E. detached patches.
12	75	W. 0° to 14° S. Fine mass of spreading faculæ.
13	75.	
14	75.	
15		A very small spot.
16	75.	
17	76.	
18	76A.	
19		A small spot.
20		A very small spot.
21		A very small spot. Patch of faculæ E.
22	77.	
23	77	E. Region of 77. W. 8° to 18° N.
24	77.	
25	77.	
26	77, 78.	
27	77, 78	Fine patches E. limb.
28	77, 78	E. 5° to 20° S.
29	77, 78, 79	Region of 79. Bright patch E.
30	77, 78, 79	E. Region of 79 extensive.
31	77, 78, 79, 80.	

NOVEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	77, 78, 79, 80, 81	Bright, 7° N. About 180° long. E. 0° to 10° S. Region of 81.
2	77, 78, 79, 80, 81	E. Round 81. W. conspicuous region of 77.
3	77, 78, 79, 80, 81	E. region of 81 and W. region of 77.
4	78, 79, 80, 81	E. around and f. 81.
5	79, 80, 81, 82	W. position of 78.
6	79, 80, 81, 82	W, 10° to 23° S., p. 79. (Last return of big spot.)
7	79, 80, 81, 82	P. and f. 79, very extensive W.
8	80, 81, 82	W. 10° to 30° S. (same).
9	80, 81, 82	Central 80.
10	80, 81A, 82	W. 3° to 16° N.
11	80, 81A, 83	W. scattered and faint patches.
12	81A, 83.	
13	82, 83	W. about 0° to 10° N.
14	83.	
15	83.	
16	83	E. to the N.
17		Two very small spots.
18	84.	W. Extensive far from limb. About 3° to 10° S. Position of 86?
19	84	E. and W. bright.
20	84	W. 7° to 17° S.
21	84.	
22	84.	
23	84.	
24	84.	
25	84.	
26	84, 86	W. region of 86.
27	86	Numerous around 86.
28	85, 86.	
29	85, 86	Patches E limb.
30	86	E. 5° to 17° S.

DECEMBER 1898.

Day.	Groups of Sun-spots.	Faculæ.
1	86.	
2	86, 87.	
3	86, 87.	
4	86, 87	W. 15° to 25° S.
5	86, 87.	
6	86, 87.	
7	86, 87	W. 5° to 10° N. Long. about 211° to 206°, nearly position of 80. (85 a return of it.)
8	86, 87	W. S. of 86. A small patch far from limb.
9	87	W. 7° to 14° S. Long. 182° to 174°. The f. nearly position of 81, ? and 14° to 16° S. Long. 172°.
10	87	Patches E. and W. small.
11	87.	
12	87.	
13	87	E. bright. 8° to 13° S. W. region of 87.
14	No spots.	
15	No spots	E. faint, far from limb. Penumbral patch.
16		Small spot.
17		Small spot.
18	88	E. round 88.
19	88	E. region of 88.
20	88	E. A very few to the S.
21	88.	
22	88 ?	E. few and faint, 14° to 23° S.
23	No spots	E. About 7° to 13° N. Long. 220° to 210°, nearly position of 80, and 23° S. Long. 220°.
24	No spots.	
25	No spots.	
26	No spots.	
27	No spots.	
28	89	E. S. f. group 89, some far from limb. Position of 90 ?
29	89, 90.	
30	89, 90	E. 16°/17°. Long. 138° to 128° nearly position of 87.
	89, 91	E. around 91.

Sun-spot Report, 1898.

LEDGER.

Jan. GROUP 1. *Long.* 311°. *Lat.* 15° N.

1–7. A normal spot, near the central meridian on the 1st, major axis about 30″. Little change took place before reaching the limb. 128 of December 1897.

Jan. GROUP 2. *Long.* 270°. *Lat.* 8° N.

1–10. A normal spot. Nucleus partly bridged on the 3rd and 4th. Major axis 25″ on the 7th. It decreased rapidly before disappearance by rotation. (Group 130 of December 1897.)

Jan. GROUP 3. *Long.* 253°. *Lat.* 12° N.?

2–3. Two faint little spots; on the 3rd only one.

Jan. GROUP 4. *Long.* 210°. *Lat.* 11° N.

2–14. A normal spot seen by Mr. Hadden (in Iowa) at 5 p.m. on the 2nd. It showed little change before reaching W. limb (at 4.18 p.m. on the 14th) except some signs of disruption on the 8th and 9th. In major axis it hardly exceeded 35″. Penumbra when near W. limb on the p. side. (A return of the leading spots of Group 124 of December 1897.)

Jan. GROUP 5. *Long.* 64°. *Lat.* 10° S.

13. A normal spot observed by Mr. Hadden in Iowa, close to E. limb at 5 p.m.
14. Penumbra wider on the f. side, nucleus bulging to the S. A misty trail s. f.
15. Two medium sized spots, the f. probably developed from the trail above mentioned.
16. The p. with large nucleus, the f. more dispersed.
19. One spot; major axis 35″.
20. Little change.
21. Decreasing; two small spots f.
22. Broken up at the rear.
23. Near limb.

Jan. GROUP 6. *Long.* 99°. *Lat.* 15° S.

15. A few dots.
16. Nine small spots.
19. A medium sized spot with divided nucleus, several small ones p. some distance apart.
20. Very much reduced; penumbra on the p. side only.
21. Nebulous; no distinct penumbra, one spot p.
22. Solitary and still more reduced.

Jan. GROUP 7. *Long.* 89° to 85°. *Lat.* 6° S.

19–23. A spot about 25″ in major axis, vertically inclined, with a little stream following, which soon decreased, the leader also dwindling.

Jan. GROUP 8. *Long.* 35°. *Lat.* 9° N.

16–23. A normal spot; major axis 30″, nucleus bridged on the 22nd and and 23rd. It showed little change, and must have decreased rapidly, not being visible on the 26th. (Four nearly normal spots were visible on the 19th.)

Jan. GROUP 9. *Long.* 358°. *Lat.* 5° N.

19. A considerable spot near E. limb.
20. Nucleus curving westward.
21. Normal, fimbriated.
22. Larger, 1′ of arc in diameter, a portion to the W. almost severed.
23. Small spots f. (not observed by members in England after this date).
26. More outliers.
27. Several portions dividing and embracing more than half of the circumference.
28. Still more broken up.
29. Only two of the smaller fragments with nuclei.
30. Nucleus single, penumbra long, oval. A bright ridge of faculæ extending along the edge nearest the limb. Whole appearance strongly suggestive of the depression theory.
31. Close to limb at 12, appearing as a long dark line, without penumbra.

Feb. GROUP 10. *Long.* 176° to 171°. *Lat.* 6° to 8° S.

4–12. Three small spots. A new outburst, with slight penumbra on the 5th. More in number, but smaller on the 7th. Not seen at 9.45 a.m. on the 8th, but observed by Prof. Pereira at 0.18. One increased a little in area, the rest gradually dying out.

Feb. GROUP 11. *Long.* 145°. *Lat.* 11° S.

4–10. A small nebulous spot which did not increase, and vanished before reaching W. limb.

Feb. GROUP 12. *Long.* 229° to 224°. *Lat.* 10° N.

7–9. Two spots with slight penumbra in the western hemisphere. The f. increased a little, penumbra wider on the p. side; on the 8th the p. soon disappeared.

Feb. GROUP 13. *Long.* 102°. *Lat.* 8° S.

7–19. A small normal spot near E. limb on the 7th. Nucleus double on the 9th; cloven on the 12th and 13th; elongated and entire when near the central meridian, with major axis 35″. It decreased before reaching the limb.

Feb. GROUP 14. *Long.* 97° to 83°. *Lat.* 5° to 8° S.

9. A few insignificant spots near E. limb. (Positions of Group 7.)
10. Rather more in number.
11. A wide stream, three spots with slight penumbra.
12. Great increase, the leader and the last spot much larger, both bridged, many smaller ones between in curves.
13. The p. quadrangular, the f. with both nucleus and penumbra curving westward, intermediates more in a line.
14. The f. nearly vertical, bridged to the S. but less curved, intermediates larger. Length of train, including Group 13, 129,960 miles. The f. spot 66″ in major axis.
15. The p. bridged, the f. broken up to the S. and merging into the intermediates, which are again altered in form and position.
16. The p. again curved, the f. with three nuclei, all of them bridged, the rest also more separated and smaller.
17. The p. two-lobed, the f. very disjointed and curving to the S.
18. The p. bridged, lesser spots fast disappearing, leaving a larger but still fragmentary one at the rear.
19. Much foreshortened, the p. normal; the rest much reduced.
20. Only the f. visible at noon.

Feb. GROUP 14A. *Long.* 87°. *Lat.* 3° N.

12. A very small pair N. f., Group 14, On the 13th and 14th several single spots widely separated appeared in advance.

Feb. GROUP 14B. *Long.* 72°. *Lat.* 9° S.

17–18. Two small spots f. Group 14.

Feb. GROUP 15. *Long.* 121°. *Lat.* 10° S.
15–17. A little cluster. On the 17th in two sets near W. limb.

Feb. GROUP 16. *Long* 16°. *Lat.* 14° S.
15–19. A small double spot, with a few outliers at some distance from E. limb on the 15th, single on the 16th and 17th; afterwards a few very small spots in a line.

Feb. GROUP 17. *Long.* 2°. *Lat.* 6° N.
15–26. A normal spot, major axis about 40″, bridged in two places on the 18th and 19th, in form like the figure 3 on the 20th; afterwards with two nuclei. (Forming a triangle with Groups 18 and 19.)

Feb. GROUP 18. *Long.* 9°. *Lat.* 1° S.
17–21. A few small spots, with slight penumbra on the 18th, varying a little in position.

Feb. GROUP 19. *Long.* 2°. *Lat.* 1° S.
17–26. A normal spot, resembling 17, bridged on the 18th, curving westward on the 19th and 20th, with three nuclei on the 22nd, dots p. on the 23rd, nucleus single on the 25th. When near limb slight penumbra on the f. side and bright faculæ on the p. (In nearly the same position as Group 9.)

Feb. GROUP 20. *Long.* 267° to 259°. *Lat.* 8° to 11° S.
22. Two very small spots near E. limb.
23. One spot.
25. With two nuclei and a little penumbra.
26. More activity. Small spots and dots p.
27. Two considerable spots.
28. Two normal spots nearly equal in area, the f. about 40″ in major axis, with a few outliers.

Mar.
1. Both with divided nuclei.
2. The f. broken up to the N.
3. The p. broken up to the S. The f. fast decreasing.
4. Both very small.
5. One spot, still more reduced.

GROUP 21. *Long.* 189°. *Lat.* 7° S.

Feb. 28–Mar. 11. Two little spots, with a few outliers on March 5. The p. increased a little in area, attaining 25″ in major axis on the 4th and 5th. The f. about half as much. On and after the 10th the p., somewhat reduced, only remained.

Mar. GROUP 22. *Long.* 279° to 276°. *Lat.* 7° to 9° N.
3. A wide pair of faint spots in the western hemisphere.

Mar. GROUP 23. *Long.* 178°. *Lat.* 14° S.
3. A small faint spot S. f. Group 21.

Mar. GROUP 24. *Long.* 150°. *Lat.* 8° S.
4–10. A spot with slight penumbra showing but little increase; small spots and dots f. One only observed on the 10th.

Mar. GROUP 24A. *Long.* 159°. *Lat.* 10° S.
8–10. A few very small spots and dots, which varied in number, preceding Group 24.

Mar. GROUP 25. *Long.* 128° to 110°. *Lat.* 10° to 13° S.

5. A small penumbral spot near E. limb.
6. Two spots nearly equal in area.
7. Both increased, many small nuclei and a few outliers.
8. A broad stream, much subdivision.
9. Components still more numerous.
10. Changing rapidly, some of the spots amalgamating. Mr. Townsend observed reversals of the C. line over one or two of the p. spots and faculæ.
11. On the central meridian, nuclei larger, the final spot now quite distinct from the rest.
12. About five considerable spots p. One exceeding the rest in area and very compound, nucleus shaded off.
13. Still changing. Nucleus of chief spot 1′ of arc in length.
14. Nucleus less elongated but more complex. Final spot more broken up and spiral in form.
15. Train more simplified and in three sections, leading spot with a portion detached on the f. side. Chief spot a mass of nuclei, but evidently disintegrated, the interior lighter in tint than the rest.
16. Chief spot splitting up, the final fast disappearing.
17. Largest spot near limb.

Mar. GROUP 26. *Long.* 116°. *Lat.* 12° N.

5. A penumbral spot near E. limb.
6. Penumbra nearly equal E. and W. A smaller spot f.
7. The f. with two nuclei.
8. Bridged, the f. broken up.
9. Nucleus tripartite.
10. More abnormal.
11. A portion to the S. severed.
12. Reuniting.
13. Gaping to the N. Nuclei in a semi-circle, none f.
14. Four nuclei.
15. Penumbra disappearing.
16. Only two small spots, without penumbra.

Mar. GROUP 27. *Long.* 104°. *Lat.* 7° S.

6–18. A normal spot which showed but little variation except in the form of the nucleus, which was double on the 7th, had a small portion severed to the S. on the 13th, and to the N. on the 14th. Major axis 45″. A few small outliers preceded from the 12th to the 16th.

Mar. GROUP 27A. *Long.* 300°. *Lat.* 10° N.

16–17. A single small spot at some distance from E. limb observed only by Prof. Pereira and Mr. Hadden. Not recorded Greenwich or Stonyhurst. But fine faculæ about position seen at Stonyhurst, March 16.

Mar. GROUP 27B. *Long.* 1°. *Lat.* 6° S.

17. One or two very small spots seen by Prof. Pereira.

Mar GROUP 28. *Long.* 8°. *Lat.* 2° S.

21–22. A pair of very small spots in the western hemisphere.

Mar. GROUP 29. *Long.* 359°. *Lat.* 2° N.

21–22. Another little pair, probably observed by Mr. Hadden on the 21st.

Mar. GROUP 30. *Long.* 217°. *Lat.* 13° S.

25–29. One or two very small spots.

Mar. 31. / April 1. — GROUP 31. *Long.* 173°. *Lat.* 15° S.
A little spot in the Eastern hemisphere, almost invisible. April 1.

Mar. — GROUP 32. *Long.* 134° to 126°. *Lat.* 12° S.
31. A penumbral spot very near E. limb at 11 a.m. (A return of Group 25.)

April.
1. Nucleus double, a smaller spot f.
2. Nucleus very irregular, penumbra nearly equal but fainter on the f. side.
3. Nucleus singularly split up lengthwise.
4. A portion severed both to the N. and S. Major axis 55″, f. spot 30″.
5. Very complex, pointed to the N., f. spot circular.
6. Further change, many small nuclei; dots f. at some distance.
7. Elongated but decreasing, little penumbra, nuclei beaded, f. spot with more outliers.
8. Scattered fragments only, p. two veiled spots.
9. One small spot only p., the f. normal.
10. Little change, the veiled spots almost gone.
11. The f. only left; faculæ extensive.
12. Little change.
13. Very near limb, faculæ streaming to the S.

April — GROUP 33. *Long.* 94° to 90°. *Lat.* 17° S.
8–13. A few dots on the 8th, E. of central meridian, increasing a little in number and area until after the 10th, when two, widely separated, only remained.

April. — GROUP 34. *Long.* 202°. *Lat.* 10° N.
22–25. One or two very small spots.

April — GROUP 34A. *Long.* 225°. *Lat.* 11° S. ?
25–29. A few very faint spots, observed only by Prof. Pereira and Mr. Hadden. Two of them increased a little in area on the 29th.

April — GROUP 34B. *Long.* 159°. *Lat.* 16° S.
26–29. At first two small spots near E. limb, as many as eight on the 28th and fifteen on the 29th.

May — GROUP 35. *Long.* 84°. *Lat.* 14° N.
2–7. A few very small spots, seen only as dots by Mr. Hadden on the 7th at 1.15 p.m.

May — GROUP 35A. *Long.* 53°. *Lat.* 8° N.
6–7. Six small spots between E. limb and Group 35, only observed by Mr. Hadden and Mr. Astbury.

May — GROUP 36. *Long.* 60°. *Lat.* 11° S.
6–10. Three little spots, increasing in number, but after the 10th one only.

May — GROUP 36A. *Long.* 34°. *Lat.* 13° S.
6–10. Two little pairs with slight penumbra, s.p. 38.

May — GROUP 37. *Long.* 46°. *Lat.* 10° N.
5–9. A few very small spots reduced to one or two dots on the 9th.

May — GROUP 38. *Long.* 23° to 13°. *Lat.* 7° S.

6. Two medium sized spots following each other.
7. Penumbra chiefly confined to the N. and S., many outliers.
8. No details.
9. The p. with oval nucleus, the f. with a bright bridge extending partly through the p. portion of the penumbra, but not across the nucleus.
10. Both more normal. A drawing by Prof. Pereira shows the umbra of the f. bridged laterally.
11. Both nearly equal in area.
12. The f. with several small nuclei.
13. The p. carrot-shaped, elongating and breaking up at the extremity into a train of small spots. The f. with penumbra on the S. side only. Many outliers eastward.
14. The p. more parallel to the equator. The f. more vertical, whole group kite-shaped.
15. Decreasing. The p. with two nuclei, the f. breaking up and with only a little penumbra.
16. Leader much reduced.
17. Nearing limb.
18. A small single spot only visible.

May — GROUP 39. *Long.* 295° to 286°. *Lat.* 8° to 11° S.

13–16. Two or three small spots near E. limb. On the 16th reduced to one.

May — GROUP 40. *Long.* 244°. *Lat.* 16° S.

16–26. A small penumbral spot near E. limb at 6 p m. on the 16th. Stonyhurst seen 4.20 p.m. A smaller one f. in close proximity, which soon disappeared. Nucleus bridged on the 22nd. Major axis 20″, a few outliers to the S. After the 23rd smaller and more irregular.

May — GROUP 40A. *Long.* 207° to 200°. *Lat.* 16° S.

22–28. Two dots, seen at 8.30 p.m. by Mr. Hadden on the 22nd. Twelve on the 25th, decreasing in number on the 28th.

May — GROUP 41. *Long.* 268°(?). *Lat.* 13° N.

18. Three very small spots not far from E. limb.

May — GROUP 42. *Long.* 195°. *Lat.* 18° N.

28. A small spot in the western hemisphere, observed only by Mr. Townsend.

May 30. / June 3. — GROUP 43. *Long.* 158° to 152°. *Lat.* 19° S.

A stream of little spots, two with penumbra on June 1 and 2. Reduced to three on the 3rd.

June — GROUP 43A. *Long.* 105°. *Lat.* 0° to 2° N.

1–7. Two or three faint little spots on the 1st not far from the central meridian, increasing a little on the 5th. Near limb on the 7th.

June — GROUP 44. *Long.* 59°. *Lat.* 6° N.

1. A small spot near E. limb.

June — GROUP 45. *Long.* 68°. *Lat.* 12° S.

5–6. When first seen, a little pair not far from the central meridian.

June — GROUP 46. *Long.* 0°. *Lat.* 19° S.

7. Two faint little spots. Possibly seen by Miss Brown on the 5th.

June — GROUP 47. *Long.* 332° to 324°. *Lat.* 13° to 16° N.

13. Four very small spots (observed by Mr. Hadden at 1.45 p.m., and probably a reappearance of a dot seen by him on the 7th).
14. Little change.
15. A stream, the final spot only penumbral.
16. Solitary, a new spot to the S.
17. About five small spots, N. and S. of each other.
18. Near W. limb.

June — GROUP 48. *Long.* 238° to 230°. *Lat.* 17° to 18° N.

16. A cluster of very small spots 46° E. of the central meridian.
17. Two little streams, parallel to each other.
18. In one stream, about 15 spots; a small spot 8° S. f.
19. No longer a stream, but a few spots widely separated, rather more S. f.
20. Fast fading at 6.30 p.m.

June — GROUP 49. *Long.* 170°. *Lat.* 10° S.

20–29. A small normal spot, about 20″ in major axis on the 24th, decreasing rapidly afterwards, and invisible when near W. limb. A very few small followers.

June — GROUP 50. *Long.* 160°. *Lat.* 12° S.

25–27. One or two faint spots f. 49.

June 25–July 1. — GROUP 51. *Long.* 86° to 78°. *Lat.* 5° to 7° S.

On the 25th a very small spot near E. limb; on the 28th three. (A veiled group closely f. was observed by Mr. Hadden on the 29th.)

June — GROUP 52. *Long.* 143°. *Lat.* 12° S.

27–29. One or two small spots following each other.

July. — GROUP 53. *Long.* 228° to 225°. *Lat.* 10° to 19° N.

15–17. A little cluster in the eastern hemisphere, in two sets, N. and S. o each other on the 16th; on the 17th one set only.

July. — GROUP 54. *Long.* 136° to 132°. *Lat.* 13° S.

19. A small spot near E. limb, with slight penumbra.
20. A smaller f.
21. Little change.
23. Both nearly equal, irregular.
24. More spots, three only with penumbra.
25. Fewer, in two sets. This group seems to have disappeared rather suddenly.

July. — GROUP 55. *Long.* 55° to 48°. *Lat.* 7° S.

29. A kite-shaped cluster of very small spots.
30. On the central meridian, more elongated, a little increase in area.
31. Two considerable spots, only dots between.

Aug.

1. Two pairs with very little penumbra, much more widely separated, no intermediates.
2. Fast decreasing, one spot p. two f. This group seems also to have vanished before reaching the limb.

July. GROUP 56. *Long.* 21° to 15°. *Lat.* 12° to 14° S.

29. A small spot at some distance from E. limb.
30. A few more f.
31. Leading spot larger than the rest, which are small and more in a stream.

Aug.

1. Leader with three nuclei.
2. Ear-shaped penumbra almost confined to the S., about six nuclei, one of the f. larger.
3. More normal and fewer nuclei. The f. scattered.
4. Quite dispersed, one nearly normal spot f.
5. Three principal spots nearly in a line.

July. GROUP 57. *Long.* 335°. *Lat.* 11° N.

31. A small penumbra spot near E. limb, a smaller f.

Aug.

1. Nucleus double, a portion of penumbra detached.
2. Ear-shaped, nucleus single, more spots f.
3. Major axis 1′ of arc.
4. Larger, vertically inclined, tapering at the upper extremity.
5. Two penumbral extensions eastward.
6. Little change.
7. Nucleus bridged. Two penumbral patches detached.
8. Solitary.
9. Signs of disruption in nucleus.
10. Normal, smaller.
11. Penumbra wider on the f. side.

Aug. GROUP 58. *Long.* 48°. *Lat.* 11° N.?

1-2. A small nebulous spot in the eastern hemisphere.

Aug. GROUP 59. *Long.* 307° to 302°. *Lat.* 9° to 13° S.

2. A penumbral spot near E. limb with double nucleus.
3. A portion detached, major axis about 50″. Two spots f.
4. Compound, larger, detached portions appearing re-united, more f. spots, the two most easterly with slight penumbra.
5. Nucleus quadrangular.
7. Nucleus split up into oblong divisions.
8. Elongated, four distinct nuclei.
9. Drawn out length-wise in a carrot-like form, p. portion cleft. Major axis 1′ 30″, f. spots altered in form and position.
10. Decreasing, split in twain, each portion with elongated irregular nucleus.
11. More separated, each with two nuclei. At 10 a.m. the f. with surrounding penumbra; at 6 p.m. without any; the f. few and small.
12. Much foreshortened and reduced, f. spots in three sets.
13. One spot near limb. At 6.10 p.m. a mere dot on the edge.

Aug. GROUP 60. *Long.* 248° to 239°. *Lat.* 9° to 13° N.

11. A cluster of about six small spots at 10 a.m. More numerous at 6 p.m. with another more compact f.
12. At 8 a.m. a stream denser at the two extremities; near the central meridian. At 5 p.m. with two penumbral, medium-sized spots.
13. Two very compound spots, major axis of each 45″ with a few intermediates.
14. Leading spot breaking-up, the f. with singular barred nuclei. A new penumbral spot to the S. At 8.30 p.m. (Iowa) decreasing, the f. with the larger nucleus of the two; many dots between.
15. Slowly decreasing, both more normal.
16. Little change, outliers fast vanishing.
17. Still on the wane, the two spots nearly equal in area.
18. Near limb, the f. only visible.
19. Close to limb at 4 p.m.

Aug. GROUP 61. *Long.* 236°. *Lat.* 10° S.

11–18. Two faint little spots on the 11th, a stream on the 12th. Final spot with slight penumbra on the 13th and 14th. Rapidly dying out afterwards and reduced to two dots on the 18th. Returned as Group 66.

Aug. GROUP 62. *Long.* 138°. *Lat.* 13° S.

21–23. A wide pair of very small spots.

Aug. GROUP 63. *Long.* 148° to 145°. *Lat.* 3° to 4° S.

22–24. Two pairs of small spots, widely separated. When near N. limb one only was observed.

Aug. GROUP 64. *Long.* 33° to 29°. *Lat.* 9° to 10° S.

26. A wide pair of penumbral spots on the central meridian.

27. Both with double nuclei.

28. Broken up and destitute of penumbra.

Aug. 26–Sept. 7. GROUP 65. *Long.* 339°. *Lat.* 9° N.

A normal spot varying but little throughout its course. In nearly the same position as 57.

Aug.

27. Penumbra wider on the f. side. Nucleus bridged in several places on the 28th, major axis about 50″.

31. A few outliers and two very small spots p. in long. 349°, lat. 7° to 8° N.

Sept.

1. When nearing N. limb smaller; faculæ closely surrounding on the 5th.

Sept. GROUP 66. *Long.* 244° to 228°. *Lat.* 11° to 16° S.

2. A large spot first observed by Mr. Hadden at 5 p.m. G.M.T., near E. limb. Penumbra to the N. and S., a little to the E., but none to the W. Six hours later more pronounced to the E. but still none to the W. Umbra appearing to protrude.

3. Nucleus large, black, and irregular, partly indented at the western edge by the influx of photospheric matter, two very small nuclei on the N. edge of the penumbra.

4. More indented to the W. A small spot f.

5. Nucleus divided, except a narrow isthmus, to the N., somewhat resembling a lintel and the two posts of a door. Many small followers.

6. A bright bridge, hooked at the end, extending across the nucleus, Mr. Wadmore describes it as seeming to stand up from the solar surface; f. spots in two clusters.

7. Three narrow bright bridges N. and S. dividing the nucleus into four parts. Two clusters of small spots f. Mr. Hadden reports that at 5.10 p.m. and 5.30 this spot and the region closely following was the centre of very active disturbance when observed with the spectroscope. At 7.10 it had nearly ceased.

8. On the central meridian, elongated and almost parallel to the equator; penumbra branching on the N. f. side. The two clusters increased and surrounded with penumbra.*

9. Major axis of large spot nearly 2′ of arc in length, or 48,000 miles, or $\frac{1}{76}$ of the solar, diameter. Whole group over 170,000 miles. Bridges singularly arched, but not entirely dividing the nucleus. F. clusters with more space between the two. The f. with many little irregular nuclei surrounding a vacant space.

10. Nucleus tapering at the eastern extremity, penumbra torn at the edges; f. spots more separated and rapidly changing.

* A drawing in the "Journal," Vol. IX., No. 2.

Sept. GROUP 66—*continued.*

11. Torn fragments of penumbra replaced by small spots. On this date Mr. Maw observed many interesting changes taking place in the nucleus, especially what he terms "veiled bridges." (*See* "Observatory," November 1898, No. 272.) F. spots again altered in form and position. Those at the rear in a semicircle.
12. Nucleus jagged and curving, with "black holes" visible in it. The f. spots decreasing, but the semicircle more pronounced.
13. Still very complex. Nucleus in two divisions.
14. Much foreshortened, penumbra spreading to the N. At 8.50 a.m. the f. spots quite distinct and rapidly decreasing in number. At 5.30 p.m. penumbra forming a singular loop, the smaller nuclei very indistinct, hardly more than one spot f. with its penumbra on the opposite (f. side) to what it was a.m.
15. At 11 a.m. two spots close to W. limb, the larger a mere line (probably the one which returned after rotation), the rearward spot with penumbra on the f. side.

Sept. GROUP 67. *Long.* 167° to 161°. *Lat.* 3° N.

11. Two small spots, observed by Mr. Hadden at 2.30 p.m.
13. A few more.
14. A curved stream, at 10.20, the first and last larger than the rest, but almost without penumbra. At 5.30 p.m. great increase, two compound spots, the intermediate almost gone. (On the meridian.)
15. Both spots nearly circular, the f. opening westward. Major axis about 30″.
16. The f. elongated, tapering to the S.W. Some outliers.
17. The p. normal; the f. broken up with no penumbra to the E.
18. The p. much reduced, the f. almost gone. No outliers.
19. One very small spot.

Sept. GROUP 68. *Long.* 174° to 169°. *Lat.* 12° S.

14. Two very small spots at 2 p.m. (not seen at 10.20 a.m.) A few more at 5.30, in two sets.
15. One spot p., a little pair f.
16. A stream, but no increase in area.
17. Many more, in two groups, hardly any penumbra.
18. The leading spot larger, with several small nuclei, fewer following.
19. Leader with two nuclei, the f. in a zizgag.
20. Tapering and broken up at the extremity. Six spots f.
21. Divided, four spots f.
22. Apparently reunited.
23. Decreasing. Two nuclei.
24. Penumbra fast disappearing. A new spot f.

Sept. GROUP 70. *Long.* 356°. *Lat.* 4° N.

23. A dot at 5 p.m. observed by Mr. Hadden.
24. A very small spot, a fainter at some distance s.p.
25. Dots only in two. (Possibly this may not be the same group.)
26. Three veiled spots.
27. Rather more conspicuous.
28. Hardly visible.

Sept. GROUP 71. *Long.* 317° to 311°. *Lat.* 11° to 13° N.

26. A single faint spot at 8.20 a.m., about 56° E. of central meridian. At 1.10 p.m. five.
27. Slightly increasing at 4.55 p.m.
28. A small penumbral spot with double nucleus. Dots streaming in front like a shower of sparks. (At 8 a.m.)
29. Immense increase in 24 hours, two considerable and very compound spots with numerous small nuclei and outliers adjacent.
30. Elongated, the two p. with penumbra on opposite sides, giving the whole a twisted appearance; rear spot normal.

GROUP 71—*continued.*

Oct.
1. Leader normal, all slowly decreasing.
2. The p. divided, the f. broken up.
3. All more reduced.
4. Two spots, the p. normal, the f. very small.

Sept. GROUP 72. *Long.* 266° to 258°. *Lat.* 6° S.
28. A penumbral spot near E. limb with a smaller one f. At 1.15 two nuclei.
29. Penumbra on the f. side.
30. The f. spot decreasing.

Oct.
1. Signs of severance.
2. Major axis 40″. The f. with divided nucleus.
3. Broken up at the extremity
4. Nucleus jagged.
5. Elongated, the f. spot without penumbra.
6. A portion to the N. severed, the f. gone. Outliers s. f.
7. On the wane.
8. Very small.
9. Still decreasing.

Sept. GROUP 73. *Long.* 240°. *Lat.* 12° S.
29. Recorded at Greenwich, on this date, but not visible at 8.20 a.m. Second return of the large September group.
30. A large spot, nucleus bridged, penumbra chiefly to the N. and S.

Oct.
1. Three distinct nuclei nearly equal in area. (*See* illustration.)
2. Somewhat quadrangular, a small penumbral spot to the N. and a few much smaller f.
3. Three distinct nuclei, major axis 1′ 30″, breadth 1′; two penumbral spots to the N. Mr. Wadmore observing by direct vision remarks that one can hardly resist the idea that the spot is a cloud formation, and that in some places one is looking through a relatively thin film of mist.
4. Nuclei more irregular, penumbra with several fissures, f. spots all very small.
5. More subdivision, penumbra expanding to the E.
6. Very complex (see illustration) bridged and broken in every direction.
7. Still more complex. Prof. Pereira reports a curious and perfect instance of a black hole, and over it a bridge. (See illustration).
8. No radical change, still bridged and fissured, penumbra less extended eastward; no f. spots.
9. Penumbra opening westward.
10. Fast decreasing; the area not half what it was on the 8th.
11. Two principal nuclei.
12. Close to limb at 11.15.

Oct. GROUP 74. *Long.* 273°. *Lat.* 10° N.
4–7. A few very small spots in a stream N. p. Group 72.

Oct. GROUP 75. *Long.* 156° to 153°. *Lat.* 11° to 12° S.
7–12. When near E. limb a group of very small spots and dots, on the 9th 14° to 15° S. By the 10th an elongated penumbral spot, major axis 40″. Broken up into a number of fragments, chiefly nuclear. On the 11th a condensed cluster. On the 14th five dots only.

Oct. GROUP 76. *Long.* 36°. *Lat.* 13° S.

18–20. A few insignificant spots.

Oct. GROUP 77. *Long.* 308° to 302°. *Lat.* 11° to 15° N.

22. A fine spot close to E. limb at 10.38. (Nearly the same position as Group 71, but long. less.

23. Very compound, in several closely contiguous sections, as if three or four spots had amalgamated; a large proportion of penumbra.

24. One principal spot; a smaller closely p. and another f.

25. No details.

26. No details.

27. At 3 p.m. much altered, the f. spot the largest of the three, the middle one being much reduced, a new one has appeared in advance.

28. More broken up, the new spot shattered. Group major axis 2′ 48″ or 75,810 miles, main spot 0·29 or 21,660 miles.

30. Decidedly reduced and elongated.

31. Dwindling.

Nov.

1. Still more reduced, the final spot quite fragmentary, the p. double.

2. One small spot only, with several dots.

3. Nearing W. limb.

Oct. GROUP 78. *Long.* 279°. *Lat.* 7° N.

26. A penumbral spot some distance from E. limb.

27. Two nuclei, a little irregular stream f.

28. No details.

30. Normal, solitary. 31 nebulous.

Nov.

1. Two nuclei. 2. Little change, only slight penumbra. 3 much reduced.

4. Small and faint.

Oct. GROUP 79. *Long.* 240°. *Lat.* 13° S.

28. A small spot near E. limb. (Recorded at Greenwich on the 27th.) (A third return of the large spot of Sept.)

30. Not more than 30″ in major axis, some scattered outliers chiefly f.

31. Leader with a portion on the f. side, as if severed, outliers fewer.

Nov.

1. Only two outliers.

2. A scattered group of small spots.

3. Much decreased; nebulous, a similar spot 6° more S. in nearly the same long.

4. The southern spot faint.

5. Both decreasing.

6. Still on the wane; southern spot gone.

7. Only just visible.

Oct. GROUP 80. *Long.* 209° to 199°. *Lat.* 4° to 8° N.

31. A few spots near E. limb hardly perceptible, observed by Mr. Bartlett at 9.15, but not seen by Miss Brown at 8.10.

Nov.

1. Great increase, the leader A, compound, major axis 45″. The f. B, consisting of a few small spots.

2. A, with several irregular small nuclei. B, a compact cluster of fairly large spots with slight penumbra.

3. Both about 50″ in major axis, with many small nuclei and still very irregular.

Nov. GROUP 80—*continued.*

4. Still increasing, A more regular but splitting across the centre, B with as many as seven principal nuclei.
5. On central meridian, A more subdivided, B breaking up.
6. Both expanding, an opening in centre of A, B closing up, with a large proportion of penumbra. Little spots in a row f. touching each other; many outliers.
7. Nucleus of A larger, especially the p. B a mass of fragments, major axis of A about 1′ 20″ of arc.
8. No details.
9. More normal but bridged, faculæ clinging to spot.
10. Two nuclei, faculæ more extensive.

Nov. GROUP 81. *Long.* 173° to 166°. *Lat.* 9° to 10° S.

1–9. One little spot. On 3rd, a cluster of very small spots which increased slightly in area, and formed two sets of spots by the 5th. On the 7th they formed a stream all with penumbra, and on the 9th were still visible though very faint.

Nov. GROUP 82. *Long.* 168° to 161°. *Lat.* 4° to 6° N.

5–13. A few spots in two compact little clusters, which formed a pair by the 6th; were normal on the 7th; the following spot breaking up on the 8th, only one small spot of the following portion remaining on the 11th.

Nov. GROUP 82A. *Long.* 178°. *Lat.* 17° S.

10. A small isolated spot.

Nov. GROUP 83. *Long.* 84° to 80°. *Lat.* 7° S.

11–16. Two little spots which have slight penumbra on following side, and some outliers on the 13th. On the 14th the spots are in a line, but little inclined to the equator, all without penumbra. On the 16th only three were visible.

Nov. GROUP 84. *Long.* 356°. *Lat.* 13° S.

18–26. A nuclear spot with axis not exceeding 20″, followed by a few small ones, in a stream on the 19th, reduced to one on the 22nd, and wholly disappeared when leader near limb on the 26th.

Nov. GROUP 85. *Long.* 213° to 209°. *Lat.* 5° N.

29-30. Two little spots widely separated, a cluster on the 30th. A return of Group 80.

Nov. 27–Dec. 8. GROUP 86. *Long.* 203°. *Lat.* 8° S.

Appeared as a penumbral spot near limb amid compact faculæ. On Nov. 29, normal, major axis 45″. On 30th a few faint outliers. On December 3rd was divided, and formed a close pair equal in area on the 4th, on the 7th was decreasing, and was much reduced by the 8th.

Dec. GROUP 87. *Long.* 131°. *Lat.* 13° S.

2–13. A spot 1′ of arc in major axis, which is nearly normal, but with an elongated nucleus by the 4th. On the 7th it began to be severed into two parts, the process being completed by the 8th. On the 9th it was changing rapidly, but was more condensed, composed of nuclei, with tongues and bridges. On the 10th the two portions were just joined by a penumbral thread. On the 11th was still more compact, with three nuclei, but again was severed when, much reduced, was nearing the limb.

Dec. GROUP 88. *Long.* 289°. *Lat.* 7° N.
19–20. A scattered group of small spots.

Dec. GROUP 89. *Long.* 180° to 182°. *Lat.* 11° S.
28–31. Two faint spots, widely separated; on the 30th four; on the 31st, much developed in two sets.

Dec. GROUP 90. *Long.* 155°. *Lat.* 13° S.
29–30. A very small spot among bright faculæ.

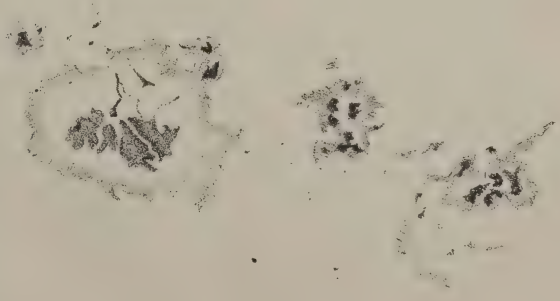
Dec. GROUP 91. *Long.* 111°. *Lat.* 5° S.
31. A spot near E. limb with slight penumbra.

Published February 20, 1900.

1898. Second and Third Appearance of Great September Group.

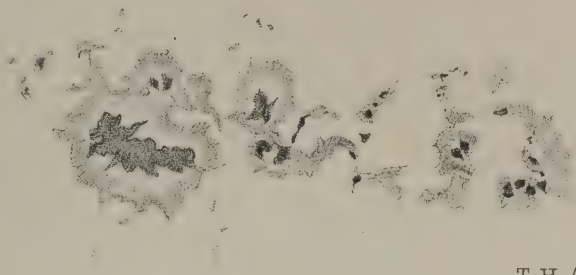
Sep.3. H. Corder, del.

Sep.7. 12. 50. T.H.Astbury, del.

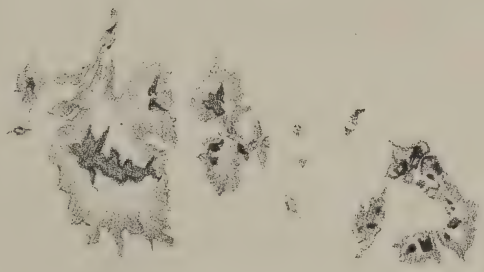


Sep.8. 12.55. T.H.Astbury, del.

1898. Second and Third Appearance of Great September Group.

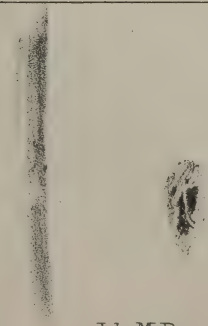


Sep. 11. 1.5. T. H. Astbury, del.



Sep. 12. 1.0 T. H. Astbury, del.

Oct. 1. H. Corder, del.



Oct. 11. J. de M. Pereira, del.

Oct. 6. J. de M. Pereira, del.

Tailby & Price, lith.

SECTION FOR ASTRONOMICAL PHOTOGRAPHY.

DIRECTORS { JOSEPH LUNT, F.R.A.S., B.Sc.
R. WILDING, F.R.A.S.

REPORT OF THE SECTION, 1897-98.

Judged by the number of Members who expressed a willingness to co-operate in the work, the Section gave early promise of being a successful one. The Directors have, however, to confess to a feeling of disappointment that many have gone no further than this initial step, and have not as yet furnished samples of their work. Others apparently are still engaged in preliminary experiments with a view to making their equipment more perfect before commencing systematic work.

Those Members who so kindly undertook to do printing, enlarging, lantern-slide making, and the thorough examination and comparison of negatives, with a view to relieving those of the night workers who have limited leisure for such work, have not been kept so busy as the Directors had hoped.

In solar photography Mr. Newbegin deserves special mention as having given us a more or less continuous record of the telescopic appearance of the sun's surface, only broken by his disinterestedness in lending his admirable instrument for the purpose of eclipse observations in India.

His photographs have been exhibited on the screen from time to time at our monthly meetings as interesting solar disturbances manifested themselves, and they are so well known and appreciated by the Members that no further description of them is needed.

Dr. Smart has, from time to time, contributed photographs of individual sun-spot groups on a larger scale and has furnished us with additional detail to that shown on Mr. Newbegin's photographs.

In lunar photography, Mr. Offord, assisted by Mr. Dykes, has done good systematic work. He has given his results in the form of a paper published in our "Journal."

In planetary photography, Mr. Longbottom and Mr. Offord have made some interesting experiments, but the day for successful planetary photography has yet to come, and visual observations remain *facile princeps* in this class of work.

In stellar and nebular photography Messrs. Ellis, Longbottom, and Evans, and Prof. Naegamvala have given us valuable records, to which the Directors have added their quota. The Directors

record with very deep regret the loss the Section has sustained by the untimely and sudden death of Mr. J. de Villiers, who was killed in the lamentable railway accident at Mostertheek, South Africa, on August 16, 1898.

Mr. de Villiers purposed devoting himself to astronomical pursuits in his retirement at Sea Point, and had erected an observatory which must be regarded as on a magnificent scale for an amateur. The building was completed, and the transit instrument and photographic equatoreal were all but finished ready for shipment to the Cape, when he was so suddenly taken from us.

His death is the more to be regretted as his sphere of work would have been the southern skies, and no doubt, had he lived, the Members would have had good opportunities of seeing portrayed on the screen some of the wonders of the heavens which northern observers may never see.

List of Members and Contributors.

Names.	Locality.	Instrument.
Allen, A. C.	Folkestone	$3\frac{1}{2}$-in. refractor.
Antoniadi, E. M.	Juvisy, near Paris	——
Bacon, Rev. J.	Newbury	12-in. reflector, $4\frac{1}{10}$-in. refractor.
Bacon, Miss Gertrude	Newbury	12-in. reflector, $4\frac{1}{10}$-in. refractor.
Clapton, T., F.R.P.S.	Harlesden, N.W.	——
Clough, Chas. E.	Southport	$9\frac{1}{4}$-in. reflector, $3\frac{1}{2}$-in. P.L.*
Dykes, F. J.	Ealing	——
Ellis, H.	Potter's Bar	9-in. reflector, 80-in. focus.
Evans, F.	Chester	6-in. refractor, $5\frac{1}{2}$-in portrait lens.
Evershed, J.	Kenley, Surrey	$2\frac{1}{4}$-in. Prismatic camera.
Forsyth, H. C. B.	Macduff, N.B.	3-in. altazimuth refractor; $1\frac{1}{2}$-in. lantern lens.
Freeman, A.	Hastings	$10\frac{1}{4}$-in. reflector, 2-in. guider.
London, W.	Woodbridge	$15\frac{1}{2}$-in. reflector.
Longbottom, F. W.	Chester	$18\frac{1}{2}$-in. reflector (altazimuth). 3-in. refractor, $2\frac{1}{2}$ in. and $5\frac{1}{2}$-in. P.L.
Lunt, J.	Cape of Good Hope	——
Maunder, E. W.	Lewisham, S.E.	——
Maunder, Mrs.	,,	——
Maw, W. H.	Kensington, W. and Outwood, Surrey.	6-in. and 8-in. refractors, 8-in. single lens, $4\frac{1}{2}$-in. P.L.
Moore, J.	Charlton	9-in. refractor.
Naegamvala, Prof. K. D.	Poona, India	$16\frac{1}{2}$-in. reflector.
Newbegin, G. J.	Norwich	9-in. and 4-in. refractors, 2-in. P.L.
Offord, J. M., F.R.M.S.	Ealing	$12\frac{1}{4}$in. reflector, $3\frac{3}{4}$-in. refractor.
Smart, Dr. D.	London, S.E.	10-in. reflector.
Wilding, R.	Bartle, near Preston.	19-in. reflector, 5-in. P.L.

* P. L. = Portrait Lens.

I.—The Sun.

Messrs. Maunder, Newbegin, Smart, and Allen have contributed photographs of the solar disk and special sun-spot groups. Mr. Newbegin has contributed by far the largest number of these, which form an admirable series. Dr. Smart has furnished 25 photographs, and Mr. A. C. Allen two experimental ones.

II.—The Moon.

Messrs. Offord, Longbottom, Newbegin, and Wilding have furnished more or less successful photographs of the surface of our satellite. Mr. Offord being *facile princeps* in this work, and having obtained most encouraging results considering that his are amateur efforts with amateur equipment.

Messrs. Smart, Moore, and Freeman have also contributed their experimental results in this field.

The more noteworthy of Mr. Offord's* photographs are given below. For further details of his equipment and methods *see* his paper "Journal of the British Astronomical Association," Vol. VIII., No. 5, p. 232).

Region.	Date.	Time.
	1896.	h m
Theophilus - - -	Aug. 27	11 45
Theophilus (smaller scale) -	„	11 30
	1897.	
Full moon - - -	Feb. 17	9 15
Gassendi - - -	Mar. 15	?
Aristarchus (showing also the Moon maiden).	„	10 20
Straight wall - - -	April 10	8 45
Plato Lunar Alps and Archimedes.	„	9 58

* Mr. Offord was often assisted by Mr. Dykes.

III.—The Lunar Eclipse of January 7, 1898.

Messrs. Longbottom and Smart are the only Members who have sent photographic records of this phenomenon.

Mr. Longbottom made 10 exposures with his 18½-inch Calver reflector, giving exposures of $\frac{1}{10}$th second with a stationery telescope. The focal length of his instrument is 10 feet 5 inches, and the scale of his photographs is nearly 2¼ inches to the lunar diameter. A print of one of these, taken at $11^h\ 52^m$, and sent with his return, is full of fine detail, and makes a capital record of the partial phase.

Dr. Smart's four photographs are an inch smaller in diameter, and not so successful as the last named.

IV.—The Planets.

This field of work is certainly the most difficult and least profitable of any which the Members can take up. Even large well equipped observatories have not been able as yet to turn out photographs which, as regards planetary detail, are worthy the time and pains bestowed upon them, and therefore amateurs with small equipment should be discouraged from attempting work in this field. The time expended could be more profitably occupied with stars and nebulæ, unless, indeed, some of our more ambitious Members turn their attention to the photographic search for faint undiscovered satellites, and even this is a field where the large observatories are more than likely to anticipate the efforts of our Members.

Messrs. Offord and Longbottom are the only Members who have attempted planetary work. Venus, Jupiter, and Saturn have each received a share of attention.

V.—Comets.

We have not been favoured by the appearance of any bright comet. Through the kindness of Her Majesty's Astronomer at the Cape of Good Hope, one of the Directors of the Section is able to contribute his photograph of Comet Coddington, taken with the 13-in. astrographic telescope with an exposure of two hours. It appears merely as a small nebulous ball with a suspicion of a short fan-like tail or an eccentric condensation.

The photograph is useful merely as showing how the Members of this section may secure fairly accurate positions for objects of this class by submitting their photographs to careful measurement. The two ends of each star trail represent the relative positions of the neighbouring stars and the comet at the commencement and end of the exposure.

One can make a paper print from the negative; place a piece of paper underneath it and prick one end of all the trails and the nucleus of the comet with a fine needle, and so obtain *diagrams* of the position of the comet with respect to the stars in the same field. Of course the centre of the nucleus of the comet must be used for guiding and not the stars, which latter must be allowed to trail as the comet moves along amongst them.

Those Members possessed of large reflectors are recommended to attempt any comet which is bright enough to show up the wires of their guiding telescopes, and so allow of guiding with dark wires on the brighter background given by the nucleus.

VI.—Meteors.

Bad weather prevailed in England during the November meteor period, and no photographs have come to hand. Judged by the display at the Cape, where clear cloudless skies were vouched to us, the shower was a very poor one, and in no way came up to expectations.

Through the kindness of Her Majesty's Astronomer at the Cape, a copy of a chance meteor caught on one of the chart plates of the International Survey, by Mr. C. Ray Woods, during the routine work, is included in our collection.

Chance meteors like this are by no means rare, and should be looked for on all negatives, and not confused with chance scratches.

VII.—Star Fields, Clusters, and Nebulæ.

This branch of work is one of the most fascinating and promising. The Members have secured a good number of negatives, many of them of excellent quality.

Messrs. Longbottom and Evans, Ellis, Naegamvala, and the Directors are the only ones who have made really serious efforts, The Directors regret that various circumstances have combined to make the first beginnings of this work rather tardy. There are still many instruments adapted for the work which, up to the present, have not been fully utilised by our Members for, no doubt, excellent reasons; but it is hoped that these may soon be pressed into the service, and that the preliminary experimental stage may soon give way to more constant and systematic efforts.

The English climate is by no means conducive to sustained regular work in this branch of astronomical photography. Who that has worked in it has not again and again adjusted his instrument and made every preparation for a good night's work, only to feel the keen disappointment of having to relinquish it on account of thick haze or denser clouds coming up to mar the clear sky which tempted him on during his preparations. Perhaps a short exposure has already been secured on an object requiring a long one when the "cease fire" has to be sounded to dodge a sudden rain squall. High winds and the dewing of object glasses account for still further wasted efforts. Whilst others have experienced the exasperating presence of beautifully clear and suitable skies on occasions when other more pressing engagements have called them elsewhere to leave their telescopes idle.

These factors apply of course to all branches of astronomical observation, but owing to the much longer time taken up in preparing an instrument for photographic work they apply most of all to those engaged in securing photographic records.

For the encouragement of those who are not possessed of driving clocks to their telescopes, Mr. Longbottom's hand-driven photographs are especially commended. His photographs were taken with a 3-in. Cooke equatoreal on a portable stand, which had to be carried in and out for each night's work, and his camera was only furnished with a Dallmeyer portrait lens of $2\frac{5}{8}$-in. aperture and $6\frac{1}{4}$-in. focus. The instrument was kept moving during the whole exposure by means of a hand slow-motion rod.

His photographs show an astonishing number or stars and great wealth of detail, and the driving is really admirable.

His longest exposures were an hour and a half, which he says is all he is capable of at one sitting, and those who have tried it will readily endorse his opinion.

His results have been sufficient to encourage him to erect a solid equatoreal with a driving-clock, on which he has erected a $5\frac{1}{2}$-in. Voigtlander portrait lens of $22\frac{1}{2}$-in. focus. No doubt he will find this far less fatiguing, and we shall expect him to give us much longer exposures in future in consequence.

Mr. H. C. B. Forsyth, Macduff, N.B., has attempted an even more difficult feat, viz., stellar photography with an altazimuth! He has forwarded a print from one of his negatives of the constellation of Orion taken by means of a $1\frac{1}{2}$-in. lantern lens, mounted on a 3-in. altazimuth refractor. Exposure 22 minutes. His enthusiasm is worthy a better equipment.

Hints to Members.

The following hints may be of use to those Members who are making their first experiments in astronomical photography, and as some may not be experienced photographers, some details of photographic procedure are added.

(1.) *Focussing.*—Never attempt to ascertain the best working focus of your object-glass by viewing a star image on a ground-glass screen.

Devote a whole night, or several nights if necessary, to this fundamental point, and make all your focussing experiments photographically.

Fix a scale on your instrument so that you can read changes of distance between lens and plate.

Having ascertained the approximate focus in the daytime by focussing a very distant object on the focussing screen, move the plate well within this point and expose a plate on the night sky in a region where there are a few bright stars.

Allow the camera to remain stationary and let a star image trail along the plate for some definite length of time, say, 2–5 min. Move the camera forward in R.A. until the star is seen in its original position in the guiding telescope, then move slightly in Dec^{n} and re-expose, say, at 5 mm. longer focus. Repeat the operation until 5 or 6 exposures have been made at plate distance intervals of 5 mm., and all at regularly increasing or diminishing Dec^{n} readings.

Let the last exposure be twice as long as the others in order that the longer trail will enable you to identify each exposure.

It will probably be found that the sharpest line is at a focus somewhere between the extreme readings.

If not, repeat the operation until it is.

This will give an approximate focus. Repeat the operation on another plate, changing the plate distance by single millimètres, this time, starting just within and ending just without the best focus found in the first trial. With longer focus instruments finally expose another plate about the best focus for the centre of the plate, changing the focus reading by half millimètres until the sharpest line is obtained. The separation of the two trails

of some convenient double star is a good test of relative sharpness for the finer focussing.

Now expose on stars, with the clock driving the telescope, at three or four focus readings close to the best focus found from the trails, changing the Dec^{n} for the second and third, and the R.A. an equal angular distance for the fourth exposure.

The best all round results will, in most cases, be obtained by making a slight sacrifice of absolute sharpness at the centre of the plate in order to obtain a fair average sharpness over a larger area. The sharpest stars will then lie in a circular zone round the centre of the plate. Judgment must be used as to how much to sacrifice in the centre. The sacrifice should not be apparent at a glance, or it is overdone.

Area of good definition.—Above all things do not let your anxiety to include a large area lead you to produce a negative looking more like a photograph of a whirlpool than anything else. Nothing looks worse than a crowd of stars apparently racing round the outer regions of your picture. Place a circular or square diaphragm in front of your plate, to cut off all such objectionably distorted images (or mask out when reproducing) even if your photograph only covers a half-a-crown, and show all your photographs as enlargements from the original.

Keep a watchful eye that the sharpest region of your photographs remains where it was intended to be, and correct for seasonal changes of temperature, if necessary.

Backed plates.—Always use backed plates for long exposures or for regions containing bright stars. Plate-makers now supply plates ready backed. These save trouble. This is especially important for solar and lunar photographs. Unbacked plates give less crisp definition owing to halation. This is seen in solar photographs as a hazy ring round the sun's limb. The haze is really overspreading the whole photograph and masking contrasts. In stellar negatives the brighter stars show spurious ring nebulæ surrounding the images. These can be effectively got rid of by proper backing.

Guiding.—The best of clocks are not to be trusted for long. Constant watchfulness is required to keep the star image from straying off the guiding wires.

Flexure of the instrument.—Reflectors are especially liable to this, and long exposures should not be attempted without some means of correcting it.

The plan adopted by Mr. W. E. Wilson, of Darramona, Ireland, is an excellent one, and avoids piercing the centre of the large mirror. The slide of the plate holder is silvered on the side facing the mirror, and can be illuminated by red light. The plate is closed at intervals, the slide being pushed home to a stop. The star image is then viewed by a small telescope, and any straying of the image from the cross lines on the silvered surface can be detected and at once corrected.

The best place for the plate is in the centre of the tube, and not, by the use of a flat, at the side, unless an enlarging lens is employed.

In developing your plate, do not let your anxiety to see what is coming out tempt you to flood the plate with an unnecessary amount of red light, which may not be so safe as you imagine. This will cause fogging, and spoil your negative.

Manipulate your plate before exposure in absolute darkness, if possible, and thoroughly test your dark-room illumination to see that an exposure of, say, 5 or 10 minutes to the light of your developing room causes no fog to appear on a test plate. Make sure that your telescopic camera is light tight. Time your development rather than *see* its progress, and only use a faint safe light momentarily towards the middle and end of development to make sure that no fogging is taking place.

Development.—There is no *best* developer. After becoming accustomed to use a particular developer which gives good clear plates, free from stain or fog, do not lightly discard it for a newer one, without careful comparative experiments.

The following is a good developer for star plates :—

Stock Solutions—

(*a.*) 1 oz. hydroquinone, 1 oz. eikonogen, add 20 ozs. of 20 per cent. sodium sulphite solution, and pour into 20 ozs. of hot water. Stir until all is dissolved, and keep in well-stoppered bottles.

(*b.*) $2\frac{1}{2}$ ozs. 20 per cent. sodium carbonate solution (made from the crystalline salt), $2\frac{1}{2}$ ozs. 20 per cent. potassium carbonate, add 15 ozs. water.

(*c.*) 10 per cent. potassium bromide solution. In use take 2 ozs. each of (*a*) and (*b*), add 4 ozs. of water and 20 minims of (*c*).

Always use freshly mixed developer, and renew your hypo-sulphite bath when it becomes stained.

In hot weather, or in hot climates, use an alum bath after the developer, but wash the plate well after alum and before fixing.

LIST OF PHOTOGRAPHS RECEIVED.

List of Photographs received.

Object.	Date.	Exposure Commenced.	Duration. Sidereal Time.	Observer.	Locality.	Instrument.		Remarks.
						Guider.	Camera.	
		h m	h m					
Cluster M 46, and Nebula Herschel IV., 39 Argûs.	1894, Feb. 24	6 2	1 30	Dr. Isaac Roberts, F.R.S.	Crowborough	—	20-in. reflector	"Knowledge," Aug. 1895, p. 182.
Spiral Nebula, M 74 Piscium.	1893, Dec. 9	1 7	3 40	,,	,,	—	,,	Sept. 1895, p. 207.
Elliptical Nebula, H I. 84 Comæ Berenicis.	1894, May 7	12 31	1 30	,,	,,	—	,,	,, ,,
Elliptical Nebula, M 65 Leonis.	,, Feb. 28	8 19	0 40	,,	,,	—	,,	,, ,,
Spiral Nebula, M 66 Leonis.	,, ,,	,,	,,	,,	,,	—	,,	,, ,,
Cluster, M 13 Herculis -	1895, June 15	16 42	0 5	,,	,,	—	,,	Oct. 1895, p. 232.
,, ,, -	,, May 28	14 51	1 0	,,	,,	—	,,	,, ,,
Nebula M 78, and H IV. 36 Orionis.	1894, Jan. 28	3 3	3 0	,,	,,	—	,,	Nov. 1895, p. 254.
Nebula near 15 Monocerotis.	1895, Feb. 13	4 20	,,	,,	,,	—	,,	Feb. 1896, p. 38.
Spiral Nebula, M 33 Trianguli.	,, Nov. 14	—	2 15	,,	,,	—	Cooke 5-in. lens	July 1896, p. 158.
Exterior Nebulosities surrounding the Pleiades.	1893, Dec. 6 and 8.	—	10 15	Prof. E. E. Barnard.	Lick Observatory, California.	—	Willard lens, 6-in. aperture.	"Knowledge," Dec. 1895, p. 281.

Nebulosity round 15 Monocerotis.	1894, Feb. 1	—	3 0	„	„	—	„	May 1896, p. 109.
Nebulosities near Antares and ν Scorpii.	1895, June 21–22.	—	7 30	„	„	—	„	Sept. 1896, p. 205.
Nebula M 8 in Sagittarius	„ May 18–19.	—	2 40	Prof. K. D. Naegamvala.	Poona, India.	—	$16\frac{1}{2}$-in. reflector	*Aug. 1896, p. 183.
Great Nebula in Orion -	—	—	—	„	„	—	—	*See* "Nature," June 17, 1897, p. 153.
M 46 Cluster, and Nebula Herschel IV. 39 Argûs.	—	—	—	„	„	—	—	—
M 22 in Sagittarius -	—	—	—	„	„	—	—	—
M 46 and H VIII. 38 Argo.								
δ Canis Majoris region -								
Milky Way in Ophiuchi	—	—	—	„	„	—	Small portrait lens.	No details received.
M 8 region, 2 overlapping fields.								
M 67 in Cancer - -								
Pleiades - - -	1896, Nov.	—	1 0	Henry Ellis	Potters Bar	—	9-in. Reflector 80-in. Focus.	
Great Cluster in Perseus -	1897, Sept. 26	—	1 0	„	„	—	„	
Orion Nebula - -	—	—	1 20	„	„	—	„	
Praesepe - - -	1898, Mar. 11	—	0 35	„	„	—	—	
„ - - -	„ „ 13	—	1 45	„	„	—	—	

* The photograph appearing in "Knowledge" is so reproduced that the wonderful detail of the original negative is altogether lost. Mr. Lunt made copies from the original negative in which the faint nebulosities are strongly brought out. For a description of the method employed *see* "Journal" British Astronomical Association, Vol. VII., No. 3, p. 132. The photograph of the Orion nebula was similarly treated.

List of Photographs Received—*continued.*

Object.	Date.	Exposure Commenced.	Duration. Sidereal Time.	Observer.	Locality.	Instrument.		Remarks.
						Guider.	Camera.	
		h m	h m					
Gap in Milky Way in Serpens.	1898, Aug.	—	1 20	Henry Ellis	Potters Bar	—	—	
M. 13 in Hercules -	,, ,,	—	1 40	,,	,,	—	—	
M. 11 - - -	—	—	2 0	,,	,,	—	—	
Constellation of Orion -	—	—	0 22	H. C. B. Forsyth	Macduff, N.B.	3-in. Refractor Altazimuth.	$1\frac{1}{2}$-in. Lantern lens.	Hand-guiding with altazimuth.
Orion's Belt and Nebula -	1897, Jan. 24	—	1 0	Messrs. Evans and Longbottom	Chester	6-in. Refractor	$5\frac{1}{2}$-in. Portrait lens.	
Region of γ Cassiopeiæ -	,, Feb. 27	—	2 0	,,	,,	,,	$2\frac{1}{2}$-in. ,, ,,	
ζ Serpentis region -	—	—	0 18	,,	,,	,,	,, ,, ,,	
α Serpentis region - -	—	—	0 30	,,	,,	,,	,, ,, ,,	
Coma Berenices - -	,, Apr. 30	—	0 25	F. W. Longbottom.	,,	3-in. Refractor	$2\frac{5}{8}$-in. ,, ,,	Hand-driving.
Region of ϵ Virginis -	,, May 3	10 10	0 40	,,	,,	,,	,, ,, ,,	,, ,,
Milky Way round χ Cygni.	,, Aug. 27	10 0	1 0	,,	,,	,,	,, ,, ,,	,, ,,

Great Nebula in Andromeda region.	„	Dec. 15	6 50	0 41	„	„	„	„ „ „	„ „
Pleiades - - -		—'	—	1 30	G. J. Newbegin	Norwich	9-in. Refractor	2-in. Dallmeyer P.L. 7 in. focus.	Clock-driven.
Region of β and γ Ursæ Minoris.	„	Apr. 30	11 30	2 30	R. Wilding	Nr. Preston	6-in. Refractor	5-in. Portrait lens.	„ „
Orion Nebula - -	„	Mar. 23	—	1 55	„	„	„	19-in. Reflector	
ζ Orionis - - -	„	„ 25	—	3 0	„	„	„	„	7 patches of Nebula and 3 Nebulous stars.
Orion Nebula - -	„	Dec. 20	—	0 50	„	„	„	„	
Region of γ Cygni - -	„	Aug. 28	10 0	2 0	„	„	„	5-in. Portrait lens 26-in. focus.	
Pleiades - - -	„	Dec. 21	—	3 50	„	„	„	„	
γ Cassiopeiæ - -	„	Nov.	—	1 0	„	„	„	„	
„ - -	„	„	—	2 30	„	„	„	„	
β Andromedæ - -	„	„	—	2 0	„	„	„	„	
Orion's belt and Nebula -	„	Jan.	—	2 0	„	„	„	„	Several well-marked Nebulæ.
ζ Orionis - - -	„	Feb.	—	2 30	„	„	„	„	
Praesepe - - -	„	Mar. 20	—	2 0	„	„	„	„	
Coma Berenices - -	„	„ 21	—	2 0	„	„	„	„	7 Nebulæ shown.

Photographs of Telescopes and Observatories.

Mr. Wilding's -	Observatory -	Bartle, nr. Preston.	Exterior.
„ - -	„ -	„ -	Interior.
Mr. Offord's - -	Reflector - -	"Run off" Hut, Ealing.	——
Mr. Evans' - -	Observatory -	Chester -	Exterior.
The late Mr. J. de Villiers'.	Observatory -	Sea Point, South Africa.	„
Dr. Smart's - -	Reflector and camera.	London -	——
„ - -	Camera detached	„ - -	——

Miss Gertrude Bacon, and Messrs. London and Clapton, have kindly undertaken to carry out printing, lantern slide making, enlarging and reducing from Members' negatives in cases where they have not the requisite leisure or appliances for the purpose. By some who have only the bare leisure for the actual night observing this kind offer will be much appreciated.

The Directors hope that this small beginning will mark the commencement of a prosperous and productive section in the near future, and that all the Members will quickly surmount their initial experimental difficulties and settle down to more regular work, and so give scope for more systematised efforts than can at present be put forth.

JOSEPH LUNT
R. WILDING } Directors.

SECTION FOR THE OBSERVATION

OF

JUPITER.

DIRECTOR.—ARTHUR COTTAM, F.R.A.S.

EIGHTH REPORT OF THE SECTION.

REPORT OF THE APPARITION OF 1898 AND 1899.

PART 1.

INTRODUCTORY.

I have followed the plan adopted by my predecessor, of dividing this Memoir into five Parts. Part 1 is a general introduction; Part 2 a general account of disk observations; Part 3 includes notes upon, and tabular statements of, observations of transits of spots, &c.; Part 4 contains satellite observations; and Part 5 contains various observations made with reference to the colours and colour changes on the Planet during the apparition.

The following is a list of the Members of the Section up to date, with the usual particulars.

Name.	Locality.	No. of Drawings.	Instrument.
WM. ANDERSON, F.R.A.S.	Madeira	3	5-in. O.G.
E. M. ANTONIADI, F.R.A.S.	Juvisy	—	—
E. ATTKINS	Highgate	25	6·5 in spec.
E. G. AYLETT	Bredgar	—	—
Rev. J. BAIKIE, F.R.A.S.	Ancrum	—	—
G. BANASTER, F.R.A.S.	Tewkesbury	—	—
W. M. BAXTER	Edinburgh	—	—
SCRIVEN BOLTON	Leeds	3	$4\frac{1}{8}$-in. O.G.
LEO BRENNER	Lussinpiccolo	—	—
J. H. BRIDGER, Mus.B.	Farnborough	3	4-in. O.G.

Name.	Locality.	No. of Drawings.	Instrument.
G. L. BROWN	Stirling	—	—
R. W. BUTTEMER	Godalming	—	—
B. E. CAMMELL, F.R.A.S.	Wokingham	—	—
H. Y. CHILDS	Portland	—	—
J. E. CLARK, B.A., B.Sc.	York	—	—
E. J. COPE	Malvern	—	—
H. CORDER	Bridgwater	—	—
ARTHUR COTTAM, F.R.A.S.	Watford	2	$12\frac{1}{2}$-in. spec.
Rev. Dr. CRAIG, B.A., F.R.A.S.	Londonderry	—	—
R. CROSS	Oxford	—	—
E. W. ELLERBECK, F.R.A.S.	Scarborough	—	—
HY. ELLIS, F.R.A.S.	Potter's Bar	—	—
E. ESSAM, F.R.A.S.	Billingboro'	—	—
J. EVERSHED, F.R.A.S.	Kenley	—	—
R. FALCON	Workington	—	—
Rev. T. H. FOULKES, M.A.	Malta	3 parts	$10\frac{1}{2}$-in. spec.
A. FREEMAN	Hastings	—	—
W. F. GALE, F.R.A.S.	Newcastle, N.S.W.	—	—
F. J. GARRARD	Louth	—	—
W. GOODACRE, F.R.A.S.	Crouch End	—	—
H. F. GRIFFITHS	Streatham	—	—
ED. HALL	Bjorneburg	—	—
W. J. HALL	Nantwich	2	$4\frac{7}{8}$-in. spec.
G. B. P. HALLOWES, F.R.A.S.	York	—	—
A. HENDERSON	Liverpool	—	—
E. R. HICKS	Kensington	—	—
Rev. R. S. HUTCHINGS, F.R.A.S.	Salisbury	—	—
W. H. IZZARD	Brentford	—	—
J. JACKSON	Blackpool	—	—
W. E. JACKSON, F.R.A.S.	Liverpool	—	—
Rev. S. J. JOHNSON, M.A., F.R.A.S.	Bridport	—	—
Rev. P. H. KEMPTHORNE, M.A., F.R.A.S.	Wellington College.	—	—
Rev. R. KILLIP, F.R.A.S.	St. Annes-on-Sea	9	5-in. O.G.
N. LATTEY	Cardiff	—	—
J. LUNT, B.Sc.	Ealing	—	—
HY. MACEWEN, F.R.A.S.	Glasgow	—	—
W. H. MAW, F.R.A.S.	Kensington	—	—
J. W. MEARES, F.R.A.S.	Calcutta	—	—
A. MEE, F.R.A.S.	Cardiff	—	—
F. K. MELLOR, F.R.A.S.	Huddersfield	—	—
Capt. P. B. MOLESWORTH, R.E., F.R.A.S.	Ceylon	2	$12\frac{1}{2}$-in. spec.
J. M. OFFORD, F.R.Met.S.	Ealing	—	—
J. ORR	Glasgow	—	—
Rev. J. D. PARKER, LL.D., F.R.A.S.	Stevenage	—	—
Dr. G. PATTERSON, M.A.	Ascot	—	—
Rev. T. E. R. PHILLIPS, M.A., F.R.A.S.	Yeovil	4	9-in. spec.
J. PHILLIPS	Hereford	—	—
W. T. PRICE	Wellington	—	—
Rev. V. REID	Glasgow	—	—
C. ROBERTS, F.R.A.S.	Kensington	—	—
Dr. RYLE, M.A.	Brighton	4	$2\frac{1}{10}$-in. O.G.

Name.	Locality.	No. of Drawings.	Instruments.
W. C. STEWART - -	Clapton -	—	—
Dr. SMART, F.R.A.S. -	Bermondsey -	1	10-in. spec.
C. F. SMITH - - -	Edinburgh -	10	$5\frac{1}{4}$-in. spec.
H. F. SMITH - - -	Luton - -	—	—
Rev. W. SWINDLEHURST -	Wickham, N.S.W.	—	—
C. A. TAYLOR - -	London -	—	—
H. J. TOWNSHEND - -	Leeds - -	9	10-in. spec.
J. M. WADMORE - -	Exmouth -	—	—
Rev. W. R. WAUGH, F.R.A.S.	Portland -	1	4·5-in. O.G.
Rev. L. A. WILLIAMS -	New Shoreham	—	—
A. STANLEY WILLIAMS, F.R.A.S.	Brighton -	—	—
H. WRIGHT - - -	Sidney, N.S.W.	3	$8\frac{1}{2}$-in. spec.
J. WYKES - - -	Birmingham -	—	—

Mr. Scriven Bolton, of Leeds, and Mr. F. J. Garrard, of Louth, have recently joined the Section. The former has contributed three drawings for the present Report.

The adopted nomenclature diagram has been inserted in the previous reports, and as the Members of the Section no doubt possess some, if not all, of the earlier reports, it appears unnecessary to insert it again in this.

Mr. Crommelin's Jupiter Tables published in the "Monthly Notices" of the Royal Astronomical Society are of great value to our Members.

The total number of drawings sent to the Director has been, from observers in Britain, 73, and from observers in other parts of the world 11, making a total of 84. Five further drawings were sent by Capt. Molesworth, but not for retention of the Association, and they have been returned to him.

PART 2.

It is hoped that the following condensed description of the principal features and characteristics of the markings on the planet, with the descriptions of the drawings representing the various sections, comprising 60° of longitude in each, will, with the drawings reproduced, sufficiently indicate the appearance of the planet during the apparition of 1898–99.

1. The equatorial zone has been brightly coloured, yellowish orange being the colour most frequently noted, and the narrow equatorial belt has been very frequently and easily visible during this apparition. Another feature that has been strongly marked has been the wisps crossing the zone between the two equatorial belts, which have been much more easily seen than is usually the

case. Mr. Killip remarks that he does not remember ever to have noticed them so readily, their striking visibility appearing to him a remarkable feature of this apparition. The belt and wisps were specially visible during May and the early part of June, and are shown on numerous drawings by Capt. Molesworth, Messrs. Phillips, Killip, Attkins, and Townshend.

2. The S. equatorial belt has been the most strongly marked feature of the Planet, usually red, often a chocolate red, or mahogany colour. The belt continues broadly double, but the narrow light rift dividing it into two portions has not been so continuous as last year. The S. edge of the belt has been dark and uniform, and the two shoulders of the red spot bay have been the only marked points. There have been numerous dark spots on the scalloped northern edge, often in juxtaposition with the brilliant white spots on the southern edge of the equatorial zone. The Great Red Spot is still a pale grey, and but rarely clearly visible.

3. The N. equatorial belt has been broader than last year. nearly if not quite as broad as the S. equatorial belt, and full of interesting detail. The estimation of its colour has varied considerably. Capt. Molesworth, at Trincomali, describes it as purplish grey rather ruddier than the S. equatorial belt. Observers in England have noticed it as greenish grey, but a few represent it as reddish. On the N. edge of the belt there has been a series of white notches, and white spots of a similar character on the belt itself. Most of the drawings show these markings.

4. The S. temperate band has not been a conspicuous feature. It is shown on almost all the drawings as a straight line merely.

5. The N. temperate band has been exceedingly faint, and it is not shown at all on many of the drawings.

6. The two tropical zones have both been well marked, white, but the southern zone decidedly the whiter, but the light spots less numerous and not so distinct as last year.

7. The N.N. and S.S. temperate bands have been very faint. They are shown on Capt. Molesworth's drawings, but on hardly any others.

8. The two polar regions have been featureless, but different in colour, the southern brownish, the northern a bluish grey.

The entire date range of the drawings is from February 26 to June 16, 1899.

The general descriptions have been divided, as heretofore, into six sections, each embracing 60° of longitude.

Section I., longitude 0° *to* 60°.—There are 20 drawings in this section, the greater part of which are comparable. The red spot bay is shown in all, and in every case the following shoulder is darker. The spot itself is shown in three drawings only. Messrs. Molesworth and Phillips in one drawing each represent

it as a grey colour, but the Rev. T. H. Foulkes, at Madeira, sends a drawing of it, and describes the colour as a "very faint washed-out red." The S. equatorial belt is shown as duplex in the portion preceding the bay in six drawings, and in the following portion in four; its colour the reddest and strongest marking on the disk. The N. equatorial belt is shown as fainter and greyer, but generally of nearly the same breadth as the S. belt. The S. tropical zone and temperate band are shown in all the drawings, and the corresponding N. zone and band as well.

Messrs. Molesworth, Phillips, Killip, Townshend, Smart, Attkins, Anderson, Charles F. Smith, Hall, Ryle, Bolton, Foulkes, and the Director contribute to this section.

Section II., longitudes from 60° *to* 120°.—There are 13 drawings in this section, mostly comparable. The general features are shown generally as described in the previous section, but the N. equatorial belt is shown duplex in almost all the drawings, and diversified with a variety of light markings. The equatorial zone is generally shown yellow or reddish yellow, and Messrs. Anderson and Smith show the faint equatorial band.

Messrs. Attkins, Bridger, Anderson, Townshend, Ryle, Killip, and Smith contribute to this section.

Section III., longitudes 121° *to* 180°.—There are 10 drawings in this section, in most of which the S. equatorial belt is shown as duplex, and a large white spot, with, in some drawings, other smaller light markings on its northern edge. Mr. Attkins, in three of his drawings, shows the equatorial band, in two of them extending from limb to limb; and Mr. Phillips, on one of his drawings, shows it in the same way, and with a slight thickening at the preceding end. In this section the N. tropical band is shown as the broadest and lightest portion of the disk.

Messrs. Attkins, Bridger, Townshend, Hall, Phillips, Smith, Killip, and Ryle have sent drawings of this section.

Section IV., longitudes 181° *to* 240°.—There are 15 drawings of this section, all of them comparable. All show the S. equatorial belt duplex from limb to limb, and most show conspicuous white markings on its northern edge with dark spots between them, from which wisps cross the equatorial zone at various angles. The equatorial band is shown on only one drawing by Mr. Killip. And in this section, as in the last, the N. tropical band is a prominent feature.

Messrs. Attkins, Killip, Smith, Waugh, and Phillips contribute drawings of this section.

Section V., longitudes 241° *to* 300°.—There are 14 drawings of this section. The S. equatorial belt is shown duplex in all the drawings, with, as in the last section, light and dark spots on its northern edge and wisps from the latter. In eight of the drawings the equatorial band is distinctly shown on the reddish

equatorial zone. The N. equatorial belt is shown broad and diversified, with light spots and markings. The S. temperate band is shown on nearly all the drawings as duplex, and the S. temperate band broader and more distinct than in the preceding sections.

Messrs. Attkins, Townshend, Bolton, Killip, Phillips, Bridger, and Wright contribute to this section.

Section VI., longitudes 301° *to* 360°.—There are eight drawings of this section, six of which agree in showing a large and prominent white spot on the northern edge of the N. equatorial belt, and another, but less conspicuous, on the northern edge of the S. equatorial belt. In other respects the drawings are not easily comparable, and they show no other well-defined features.

Messrs. Bolton, Townshend, Attkins, Smith, and Wright contribute drawings of this section.

Capt. Molesworth has sent five drawings besides the two for the Album, which have been returned to him. They are in accordance with drawings by other Members of similar longitudes, and have not been included in the above descriptions.

Of the drawings received, 12 have been selected for reproduction in this Memoir. They have been chosen with a view to showing as far as possible the characteristics of the markings in each section described above.

It has been considered sufficient that the drawings reproduced should speak for themselves without giving a written description. The whole of the drawings can be referred to in the Album for 1898-99.

PART 3.

TRANSITS OF SPOTS, &c.

Capt. Molesworth and the Rev. T. E. R. Phillips have given special attention to the transits of dark and white spots on the disk, and their rotation periods.

Capt. Molesworth's notes and observations are very elaborate and complete, and are much too copious for entire reproduction. It is not at all an easy matter to do justice to his work in an abstract of it. He gives 38 folio pages of observations of 138 spots in 15 different belts and zones, extending from 31st May to 22nd September, followed by 44 pages of details of the various spots observed, and summaries and analyses of results.

The following is one of his tables showing the mean rotation periods deduced from his transit observations. His first column, giving the zones, has been omitted as he has a special method of lettering them, but the second column, giving approximate

latitude, and the column of "Description of Objects," will make the table sufficiently clear:—

MEAN ROTATION PERIOD OF SPOTS DEDUCED FROM TRANSIT OBSERVATIONS.

Approximate Latitude.	Number of Objects.	Description of Objects.	Average Drift.	Average Rotation Period.	Average Number of Transits.	Average Number of elapsed Rotations.
°			°	h m s		
−40	3	Dark spots in S. temperate belt.	−·3509	9 55 05·6	3·33	105
−33	5	White spots in S. temperate zone.	−·2493	9 55 15·87	3·40	109
−26	15	Dark spots and streaks in S. tropical belt.	−·2470	9 55 16·01	5·46	167
−8 to −15	4	Markings in neighbourhood of Red Spot Bay.	+·0176	9 55 41·98	14·25	248
− 8	5	White spots in centre of S. equatorial belt.	Not taken.	9 54 44·56	3·80	137
− 6	23	Dark spots in N. edge of S. equatorial belt.	*−·0523	9 50 24·85	7·30	204
− 5	19	White spots in S. edge of equatorial zone.	*−·0925	9 50 20·89	5·16	181
± 0	8	Dark spots and streaks in equatorial band.	*−·0006	9 50 29·94	3·39	159
+ 6	4	White spots in N. edge of equatorial zone.	*−·0032	9 50 29·68	4·25	128
+ 7	10	Dark spots at S. edge of N. equatorial belt.	−·2042	9 55 20·26	4·30	154
+10	10	Dark and white spots, centre of N. equatorial belt.	−·0565	9 55 35·01	5·00	183
+12	14	Dark spots at N. edge, N. equatorial belt.	−·1006	9 55 30·64	6·57	179
+12	7	White notches in N. edge, N. equatorial belt.	−·1947	9 55 31·22	6·86	155
+20	6	Dark streaks in N. tropical zone.	+·2598	9 56 06·41	4·50	123
+28	5	Dark streaks in N. temperate belt.	+·3718	9 56 17·54	4·40	173
Total	138				5·70	170

The drifts marked thus * refer to Marth's System i., the rest to Marth's System ii.

This Table, Capt. Molesworth remarks, contains the gist of all the observations for longitude recorded in the book containing all these observations. Out of more than 1,100 recorded transits, nearly 800 (or about two thirds) have been utilised for the determination of the rotation periods of 138 spots, giving an average of 5·70 transits extending over 170 rotations of each spot.

The book also contains 20 diagrams giving graphical representations of the various tables.

In his remarks upon the currents of the S. equatorial belt, he says:—"There is a great difference in the periods of the currents "extending over the S. equatorial belt. This is accentuated "in the narrow isthmus between the Red Spot Bay and the "equatorial zone. At the centre of the bay the breadth of the "belt is narrowed down to almost nothing; but the N. edge of "this narrow portion has a period of $9^h\ 50^m\ 24^s{\cdot}8$, while the "S. edge has a period of $9^h\ 55^m\ 41^s{\cdot}9$.

"From the motion of the white spots in the centre of the "S. equatorial belt, I am inclined to adopt a mean period of "$\pm 9^h\ 54^m\ 44^s$ for these spots, which is intermediate between

"that of the Red Spot Bay and the spots in the N. edge of the "belt. I have traced these white spots right up to the following "shoulder, but have never seen them in the narrow isthmus "between the Red Spot Bay and the equatorial zone. They "would naturally be invisible in the bright double portion of the "belt preceding the Red Spot Bay, but can once more be traced "at the preceding end of the double portion. At this point the "more luminous centre of the belt seems to have a continuous "motion in a preceding direction. Presently a faint wisp moves "across near the preceding end, cutting off a circular white spot, "which rapidly increases its distance from the double portion, "and sets off down the centre of the belt as a separate spot.

"The question is, what becomes of these white spots when "their motion brings them to the following shoulder? They do "not, I think, pass *over* the shoulder; as I have never seen the "latter notched, as it would be, by the passage of a white spot. "They do not pass *round* the isthmus, or if they do they are "invisible during the passage. They cannot be absorbed, as "they re-appear at the other end of the double portion preceding "the red spot.

"The only alternative seems to be that these white spots pass "*under* the following shoulder, and probably under the Red Spot "itself. But this involves two very curious points:—First, the "existence of two absolutely distinct currents in the Jovian "atmosphere superimposed one on the other; and secondly, the "existence of a comparatively rapid current under the Red Spot, "which has hitherto been looked upon, from its permanence, as "the marking which is most likely to represent the actual motion "of the body of the planet. The question is a most interesting one, "and the motion of these spots should be most carefully studied."

Captain Molesworth discusses the question of the relative levels of the various markings, and states his impression that the darker markings are at a relatively higher level than the light ones. He concludes, "A careful consideration of the equatorial zone and "equatorial band tends to confirm the impression that the darker "markings are at a relatively higher level. The delicate wisps "would be very difficult to explain if the contrary was the case, "and the rapid changes in their inclination to the equatorial "belts would imply enormous movements in the brighter matter "of the equatorial zone."

As regards the Great Red Spot, Captain Molesworth remarks that it is very faint indeed, but still visible. It appears as the faintest possible grey stain with no trace of red. A consideration of the longitude observations seems to show that the breadth of the Red Spot Bay from shoulder to shoulder has decidedly increased. He has taken observations of the longitudes of three points PS the preceding shoulder, RS the centre at the northern edge of the Red Spot Bay, and FS the following shoulder.

The longitudes of these three spots at various periods are given as follows:—

	PS	RS	FS
	°	°	°
June 1898 - -	5	25	42
June 1899 - -	19·5	36·5	55
September 1899 -	19·5	39	62

The width of the bay was, therefore, 37·0° in June 1898; 35·5° in June 1899; but had increased to 42·5° in September 1899.

Comparing the results of the 1899 observations with those of the previous year, the mean rotation periods of the three points come out as follows :—

Spot.	Inclusive Dates.	Shift in Longitude.	Number of Rotations.	Mean Rotation Period.
		°		h m s
PS	April 4, 1898, to September 17, 1899.	13·62	1286	9 55 41·68
RS	April 2, 1898, to September 22, 1899.	18·73	1300	9 55 42·05
FS	March 26, 1898, to September 22, 1899.	20·90	1317	9 55 42·21

From this it will be seen that the motion of RS, which he thinks fairly represents that of the Great Red Spot, has practically remained constant since April 1898, its period being almost exactly $9^h\ 55^m\ 42^s{\cdot}0$.

The Rev. T. E. R. Phillips, of Yeovil, whose observations of transits of spots are next to Captain Molesworth's—the most numerous,—has arrived at the same rotation period for the Great Red Spot.

The following is the summary of his observations which he has furnished.

ROTATION PERIOD OF THE RED SPOT IN 1899.

A considerable number of transits of this remarkable object, and of the well-known hollow in the S. equatorial belt were secured between the beginning of January and the early part of August.

The mean period worked out as—

$$9^h\ 55^m\ 42^s{\cdot}1,$$

but the rate of motion was perceptibly quicker than this during the early part of the apparition. The acceleration of velocity, doubtless, commenced during the autumn of 1898, as at the beginning of January 1899 the longitude of the spot was about 4° less than that computed according to its rate of motion during the previous apparition.

The increased velocity thus indicated was maintained at the beginning of 1899, the rotation period at this time differing but slightly from that of the zero meridian of System II. (Mr. Crommelin's Ephemeris).

ROTATION PERIOD OF THE GREAT EQUATORIAL CURRENT IN 1899.

An immense amount of detail was visible in the equatorial regions of the planet during the apparition of 1899, and numerous observations were made at Yeovil with the object of determining the present velocity of the surface material in this latitude.

Thirty-four spots at or close to the N. edge of S. equatorial belt, and 21 at the S. edge of the N. equatorial belt (which had greatly developed since the appariton of 1898) were sufficiently well observed to enable their rotation periods to be deduced. In a few instances the matter of correct identification of S. equatorial spots presented some difficulty, as the spots at times were very erratic in their movements, but it is believed that the mean results arrived at are to be relied on as being very near the truth.

—	Number of Spots observed.	Rotation Period.
		h m s
Spots at N. edge of S. equatorial belt -	34	9 50 24·66
Spots at S. edge of N. equatorial belt -	21	9 50 26·22

The corresponding values in 1898 were :—

Spots at N. edge of S. equatorial belt -	19	9 50 24·2
Spots at S. edge of N. equatorial belt -	3	9 50 24·5

The following is a table of the individual spots observed during the apparition of 1899.

W = white spot. D = dark spot.

SPOTS AT N. EDGE OF S. EQUATORIAL BELT.

No.	W. or D. Spot.	Interval between First and Last Observations.	Approximate λ on May 1st. System I.	Rotation Period.	Remarks.
		Days.	°	h m s	
1	W.	194	359	9 50 24·7	17 observations. Motion erratic.
2	D.	139	9	9 50 24·8	10 observations.
3	W.	132	18	9 50 22·8	Only 6 observations, but identity pretty certain.
4	D.	203	27	9 50 20·9	8 observations.
5	W.	203	33	9 50 21·5	11 observations.
6	D.	110	46	9 50 22·9	7 observations.
7	W.	69	—	9 50 22·0	Spot apparently not formed till middle of May.
8	D.	182	52	9 50 25·7	11 observations.
9	W.	182	74	9 50 26·2	15 observations.
10	D.	90	89	9 50 28·1	14 observations.
11	W.	55	98	9 50 26 7	6 observations.
12	D.	55	109	9 50 27·2	Few observations, but identification certain.
13	W.	162	120	9 50 24·3	12 observations.
14	D.	194	131	9 50 25·3	13 observations.
15	W.	194	140	9 50 26·2	7 observations.
16	D.	96	148	9 50 30·4	Not seen till beginning of May.

No.	W. or D. Spot.	Interval between First and Last Observations.	Approximate λ on May 1st. System I.	Rotation Period.	Remarks.
		Days.	°	h m s	
17	W.	164	155	9 50 29·7	Not very well observed.
18	D.	219	170	9 50 29·6	13 observations.
19	W.	109	—	9 50 25·9	Not seen after end of April.
20	D.	79	—	9 50 31·8	Not seen after end of March.
21	W.	107	198	9 50 24·0	Few observations. Spot vague and faint.
22	D.	111	208	9 50 27·4	7 observations.
23	W.	194	221	9 50 23·1	14 observations.
24	D.	212	230	9 50 22·8	27 observations.
25	W.	173	243	9 50 22·8	22 observations.
26	D.	85	255	9 50 19·2	9 observations.
27	W.	97	265	9 50 18·6	10 observations.
28	D.	173	274	9 50 25·1	23 observations.
29	W.	139	290	9 50 23·3	21 observations. Exceedingly brilliant, especially about April 10.
30	D.	111	301	9 50 21·6	21 observations.
31	W.	111	319	9 50 19·2	17 observations.
32	D.	187	330	0 50 25·2	16 observations.
33	W.	48	342	9 50 23·0	6 observations.*
34	D.	47	349	9 50 26·1	5 observations.*

* These spots apparently developed at the end of April.

SPOTS AT S. EDGE OF N. EQUATORIAL BELT.

1	D.	116	346	9 50 20·4	7 observations.
2	W.	60	8	9 50 30·4	Few observations, but identity certain.
3	D.	30	—	9 50 17·2	Not observed till May 22nd.
4	W.	71	36	9 50 33·4	Only 3 observations.
5	D.	64	57	9 50 29·1	8 observations.
6	W.	69	69	9 50 29·1	6 observations.
7	D.	74	80	9 50 28·9	5 observations.
8	W.	70	99	9 50 21·4	9 observations. Bright.
9	D.	69	111	9 50 28·6	7 observations.
10	D.	53	150	9 50 26·9	Only 4 observations.
11	D.	60	182	9 50 22·4	5 observations.
12	W.	55	194	9 50 24·7	7 observations.
13	D.	68	203	9 50 24·7	Only 4 observations.
14	D.	90	214	9 50 24·4	6 observations.
15	D.	70	230	9 50 24·8	Only 3 observations, but identification pretty certain.
16	W.	64	248	9 50 27·3	9 observations.
17	D.	171	262	9 50 26·0	11 observations. Very dark.
18	W	44	274	9 50 23·7	6 observations.
19	D.	95	295	9 50 31·4	10 observations.
20	W.	68	312	9 50 30·8	6 observations.
21	D.	30	324	9 50 25·2	Only 3 observations.

Mr. Walter J. Hall, of Nantwich, has furnished the following Tables of Spot Transits observed by him :—

1899.

SPOT TRANSIT, TABLE NO. 1.

The "Bay" of the Great Red Spot.

Date.	G.M.T.	Wt.	λ System II.	Remarks.
	h m		°	
Apr. 17 -	10 12	1	50·0	*f* end of "bay."
May 4 -	8 47	1	35·4	Middle „
„ 4 -	9 13	2	51·1	*f* end „
„ 6 -	9 56	1	17·8	*p* end „
„ 6 -	10 19	est.	31·7	Middle „
„ 6 -	10 50	1	50·4	*f* end „
„ 11 -	9 58	est.	50·9	*f* end „
„ 18 -	9 45	est.	15·4	*p* end „
„ 18 -	10 45	est.	51·7	*f* end „
„ 23 -	9 2	1	21·2	*p* end „
„ 23 -	9 24	est.	34·5	Middle „
„ 23 -	9 48	1	49·0	*f* end „
„ 30 -	10 12	est.	35·6	Middle „
„ 30 -	10 37	1	50·7	*f* end „
June 6 -	10 28	1	17·2	*p* end „
„ 16 -	9 40	1	50·7	*f* end „

Rotation Period, $9^h\ 55^m\ 40^s{\cdot}6$. No change in rate.

1899.

SPOT TRANSIT, TABLE NO. 2.

Light Spot overlying S. Equatorial Belt.

May 6 -	9 26	1	0·3	Very prominent overlying white spot.
„ 6 -	9 33	1	4·5	*f* end of same.
June 6 -	10 0	est.	0·3	

Rotation Period, normal, viz., $9^h\ 55^m\ 40^s{\cdot}6$.

4. 1899.

SPOT TRANSIT, TABLE No. 3.

Dark Spot on N. Side of S. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m			
Apr. 22 -	12 13	1	6°.5	A prominent indentation in equatorial zone.
May 22 -	10 30	est.	3·6	
„ 29 -	9 57	1	9·1	
„ 31 -	11 10	1	9·4	Dark rift seen from this spot across the equatorial zone to spot No. 4.

Rotation Period, $9^h\ 50^m\ 33^s{\cdot}1$.

4. 1899.

SPOT TRANSIT, TABLE No. 4.

Dark Spot on S. Side of N. Equatorial Belt.

May 31 -	11 30	est.	21·6	A rift from this spot crosses the equatorial zone to spot No. 3.
June 5 -	9 35	est.	21·0	

Rotation Period, $9^h\ 50^m\ 25^s{\cdot}1$.

4. 1899.

SPOT TRANSIT, TABLE No. 5.

Dark Spot on N. Side of S. Equatorial Zone.

Mar. 18 -	12 20	1	239·3
May 3 -	10 21	est.	236·1

Rotation Period, $9^h\ 50^m\ 27^s{\cdot}2$.

♃. 1899.

SPOT TRANSIT, TABLE No. 6.

Dark Spot on S. Side of N. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m		°	
Mar. 18 -	13 0	1	263·7	
Apr. 17 -	11 17	1	261·8	

Rotation Period, $9^h\ 50^m\ 27^s\cdot5$.

♃. 1899.

SPOT TRANSIT, TABLE No. 7.

Dark Spot on N. Side of S. Equatorial Belt.

May 3 -	11 21	2	272·7	
June 2 -	9 35	est.	267·1	

Rotation Period, $9^h\ 50^m\ 22^s\cdot5$.

♃. 1899.

SPOT TRANSIT, TABLE No. 8.

Light Spot on N. Side of S. Equatorial Belt.

Apr. 22 -	10 22	1	298·2	Large white spot.
May 3 -	11 31	1	278·7	*p* end.
„ 3 -	11 52	1	291·6	Middle.
„ 3 -	12 10	1	302·5	*f* end.
„ 31 -	8 50	est.	283·7	
June 2 -	9 55	est.	279·2	

Rotation Period, $9^h\ 50^m\ 12^s\cdot7$.

2. 1899.

SPOT TRANSIT, TABLE NO. 9.

Dark Spot on N. Side of S. Equatorial Belt.

Date.	G.M.T.	Wt.	λ System I.	Remarks.
	h m		°	
May 6 -	9 5	1	303·8	
„ 31 -	9 8	est.	294·7	Dark rift n.f. to N. equatorial belt.

Rotation Period, $9^h\ 50^m\ 15^s\cdot4$.

2. 1899.

SPOT TRANSIT, TABLE NO. 10.

Dark Spot on S. Side of N. Equatorial Belt.

Feb. 11 -	19 22	—	7·6	T. E. R Phillips in "E.M.," May 5, p. 267.
Mar. 20 -	16 45	—	357·2	
Apr. 22 -	11 46	1	349·5	
May 6 -	10 8	1	342·2	

Rotation Period, $9^h\ 50^m\ 18^s\cdot2$.

2. 1899.

SPOT TRANSIT, TABLE NO. 11.

Light Spot on S. Side of Equatorial Zone.

Apr. 22 -	11 53	1	354·0
June 14 -	9 4	1	343·2

Rotation Period, $9^h\ 50^m\ 21^s\cdot6$.

2. 1899.

SPOT TRANSIT, TABLE NO. 12.

Light Spot on Equatorial Zone.

Apr. 22 -	12 1	1	359·2	
May 22 -	10 15	1	354·6	Large white spot extending threequarters the way across the zone.

Rotation Period, $9^h\ 50^m\ 23^s\cdot8$.

1899.

SUMMARY OF ROTATION PERIODS OF SPOTS.

Spot No.	Kind.	Rots.	h	m	s
1	G.R.S. "Bay"	145	9	55	40·6
2	Light	75	9	55	40·6

Equatorial Current.

3	Dark	95	9	50	33·1
4	,,	12	9	50	25·1
5	,,	112	9	50	27·2
6	,,	73	9	50	27·5
7	,,	73	9	50	22·5
8	Light	100	9	50	12·7
9	Dark	61	9	50	15·4
10	,,	204	9	50	18·2
11	Light	129	9	50	21·6
12	,,	73	9	50	23·8

Mean for the Equatorial Current, $9^h\ 50^m\ 22^s{\cdot}7$.

Lindum House,
Nantwich.

WALTER J. HALL.

The attention of the Members of the Section is directed to two papers that have recently been printed in the "Monthly Notices" of the Royal Astronomical Society; one by the Rev. T. E. R. Phillips on "The Equatorial Currents of Jupiter in 1899," Vol. XL., p. 210, and the other by Mr. G. W. Hough, Director of the Dearborn Observatory, Evanston, U.S.A., "Observations on the Spots and Markings on the Planet Jupiter," made at that Observatory, Vol. XL., p. 546. This paper relates to observations made during a period of 20 years, and Mr. Hough's "Conclusions" at the end of the paper deserve careful study.

PART 4.

SATELLITE OBSERVATIONS.

The satellite observations are less numerous than usual, probably owing to the unfavourable position of the planet. None have been received from observers at the Antipodes, whose opportunities have probably been greater than ours. The fullest returns are those of Capt. Molesworth, whose station in the clear air of Ceylon, and whose large telescope, have enabled him to do some excellent work in this department as usual. Two other observers have sent statements—the Rev. Theodore E. R. Phillips, Yeovil, and Mr. J. H. Bridger, Farnborough.

The following tabular statement combines the observations of the three, and the observations of each are distinguished by the initial letters M., P., and B. respectively.

PHENOMENA OF JUPITER'S SATELLITES.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
Apr. 4	II. Tr. E.	External contact.	13 53 0	13 54 0	P.	
Apr. 21	I. Sh. I.	First seen	11 5 0	11 7 0	P.	
—	—	External contact.	11 11 0	11 13 0	P.	
May 6	II. Tr. I.	Do.	9 43 0	9 42 0	P.	
May 7	I. Tr. I.	Do.	9 5 30	9 7 0	P.	
—	—	Bisection	9 8 30	—	P.	
—	—	Internal contact.	9 12 0	—	P.	
—	I. Tr. E.	Do.	11 12 0	—	P.	
—	—	Bisection	11 16 0	—	P.	
—	—	External contact.	11 19 0	11 18 0	P.	Invisible after $11^h\ 34^m$ through blurring of the image.
May 22	I. Oc. D.	First contact.	9 51 0	—	P.	
—	—	Disappeared.	9 53 30	9 52 0	P.	
May 23	I. Tr. E.	External contact.	9 16 30	9 16 0	P.	
May 29	II. Oc. D.	First contact.	11 0 30	—	P.	
—	—	Disappeared.	11 4 30	11 2 0	P.	
—	I. Oc. D.	First contact.	11 36 0	—	P.	
—	—	Disappeared.	11 40 0	11 36 0	P.	
May 30	I. Tr. E.	Internal contact.	10 56 0	—	P.	
—	—	Bisection	11 0 0	—	P.	
—	—	Just clear	11 3 0	11 3 0	P.	
May 31	III. Ec. R.	Just glimpsed.	10 0 0	10 2 55	P.	
—	III. Ec. R.	Glimpsed	10 0 45	—	B.	
—	—	Bright	10 5 55	—	B.	

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
June 2	II. Ec. R.	First glimpse.	4 7 44	4 10 0	M.	
—	—	Fully bright.	4 9 54	—	M.	
June 7	II. Tr. E.	Internal contact.	10 12 0	—	P.	
—	—	Just clear	10 19 30	10 12 0	P.	
—	III. Oc. R.	First seen	10 25 0	10 27 0	P.	
—	—	Just clear	10 34 0	—	P.	
—	I. Ec. R.	Just seen	10 55 0	10 55 14	P.	
—	II. Sh.	On disk	—	—	P.	Dark grey, not black.
June 8	I. Tr. I.	First contact.	5 3 36	5 6 0	M.	
—	—	Last contact.	5 7 36			
—	—	On disk	5 9 21	—	M.	Fading.
—	—	Do.	5 17 36	—	M.	Elongated.
—	—	Do.	5 20 21	—	M.	No longer visible.
June 8	I. Sh. I.	First contact.	6 0 51	6 2 0	M.	
—	—	Last contact.	6 4 6			
June 9	I. Oc. D.	First contact.	2 17 29	2 18 0	M.	
—	—	Gone	2 19 24			
—	II. Oc. D.	First contact.	2 30 44	2 35 0	M.	
—	—	Gone	2 35 44			
—	I. Ec. R.	First glimpse.	5 23 9	5 23 49	M.	
—	—	Fully bright.	5 25 14	—	M.	
June 14	I. Oc. D.	First contact.	9 37 0	—	P.	
—	—	Disappeared.	9 42 0	9 39 0	P.	
—	II. Tr. I.	External contact.	10 19 0	10 15 0	P.	
—	—	Bisection	10 22 30	—	P.	
—	—	Internal contact.	10 27 0	—	P.	
June 15	I. Tr. E.	Do.	9 2 0	—	P.	
—	—	Bisection	9 5 0	—	P.	
—	—	External contact.	9 8 0	9 7 0	P.	
—	I. Sh. E.	Internal contact.	10 0 0	—	P.	Shadow very black and sharply defined.
—	—	Just gone	10 7 0	10 8 0	P.	
June 16	I. Oc. D.	First contact.	4 5 3	4 6 0	M.	
—	—	Gone	4 8 53			
—	II. Oc. D.	First contact.	4 55 48	5 0 0	M.	Optical flattening of limb just before first contact.
—	—	Gone	5 1 28		M.	
June 17	I. Tr. I.	First contact.	1 19 39	1 22 0	M.	
—	—	Last contact.	1 23 26			
—	I. Sh. I.	First contact.	2 24 59	2 25 0	M.	

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
June 18	II. Sh. Tr.	On Central Meridian.	2 39 24	—	M.	
—	III. Tr. I.	Just inside disk.	2 18 24	—	M.	Very luminous.
—	III. Tr. E.	After first contact.	3 39 24	3 45 0	M.	
—	—	Last contact.	3 52 24			
—	III. after Tr.	On sky	4 25 0	—	M.	Very faint; fainter than II. or I.
—	—	Do.	5 1 0	—	M.	Now decidedly brighter than II.
June 21	I. Oc. D.	Dis appeared.	11 30 0	11 28 0	P.	
June 23	I. Oc. D.	First contact.	5 54 37	5 56 0	M.	
—	—	Gone	6 1 6			
June 25	II. Tr. I.	First contact.	1 54 13	1 51 0	M.	
—	—	Last contact.	1 59 13			
—	II. Tr. E.	First contact.	4 11 3	4 11 0	M.	
—	—	Last contact.	4 16 28			
—	II. Sh. I.	Do.	4 15 53	4 11 0	M.	
—	—	On Central Meridian.	5 9 48	—	M.	
—	III. Tr. I.	First contact.	5 18 53	5 32 0	M.	
—	—	Last contact.	5 38 43			
June 27	II. Ec. R.	First glimpse.	1 18 44	1 21 19	M.	
—	—	Fully bright.	1 22 24	—	M.	
June 29	III. Ec. R.	First glimpse.	1 55 21	1 56 39	M.	
July 2	I. Oc. D.	First contact.	2 13 53	2 14 0	M.	
—	—	Gone	2 17 23			
—	II. Tr. I.	First contact.	4 20 43	4 18 0	M.	
—	—	Last contact.	4 24 3			
—	I. Ec. R.	First glimpse.	5 34 52	5 36 0	M.	
—	—	Fully bright.	5 37 43	—	M.	
July 3	I. Tr. E.	First contact.	1 40 26	1 44 0	M.	
—	—	Last contact.	1 44 1			
—	I. Sh.	On C.M.	1 40 46	—	M.	
July 4	II. Oc. R.	Half off	1 31 30	1 33 0	M.	Not quite bisected.
—	—	Clear	1 36 30		M.	
—	II. Ec. D.	Fading	1 37 50	—	M.	
—	—	Gone	1 43 30	1 43 22	M.	
—	II. Ec. R.	First glimpse.	3 57 30	3 58 41	M.	
—	—	Fully bright.	4 1 0	—	M.	
July 6	III. Oc. R.	Clear	1 16 43	1 14 0	M.	
—	III. Ec. D.	Fading	4 18 28	—	M.	
—	—	Still circular.	4 19 58	—	M.	

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
July 6	III. Oc. D.	Gone	4 33 54	4 27 33	M.	
—	III. Ec. R.	First glimpse.	5 51 18	5 55 4	M.	
—	—	Fully bright.	—	—	M.	Not noted. Clouds.
July 8	I. Tr. E.	First contact.	9 7 53	—	B.	
—	—	Bisected	9 9 33	—	B.	Unsteady.
—	—	Last contact.	9 11 26	—	B.	
July 9	I. Oc. D.	First contact.	4 1 44	4 6 0	M.	
—	—	Gone	—		M.	Not noted. Clouds.
July 10	II. Tr. I.	First contact.	1 23 42	1 24 0	M.	
—	—	Last contact.	1 26 59			
July 11	II. Oc. D.	First contact.	1 40 1	1 44 0	M.	
—	—	Gone	1 46 16			
July 13	III. Ec. R.	Glimpsed	9 53 50	—	B.	
—	—	Bright	10 0 19	—	B.	
July 16	II. Tr. I.	External contact.	9 18 8	—	B.	Fairly steady.
—	—	Bisected	9 19 19	—	B.	Twilight.
—	—	Internal contact.	9 21 3	—	B.	
—	I. Ec. R.	Glimpsed	9 25 26	—	B.	
—	—	Bright	9 27 3	—	B.	
July 18	I. Ec. R.	First glimpse.	3 53 44	3 54 3	M.	
—	—	Fully bright.	3 56 24	—	M.	
—	II. Oc. D.	First contact.	4 16 14	4 19 0	M.	Disappearance.
—	—	Gone	4 20 14	—	M.	Perfectly regular.
—	II. Ec. R.	Glimpsed	9 11 49	—	B.	
—	—	Bright	9 14 3	—	B.	
July 25	II. Oc. R.	Glimpsed	9 17 23	—	B.	
—	—	External contact.	9 20 35	—	B.	
Aug. 1	I. Oc. D.	First contact.	4 16 39	4 18 0	M.	
—	—	Gone	4 20 14			
Aug. 2	I. Tr. I.	First contact.	1 35 19	1 37 0	M.	
—	—	Last contact.	1 38 14			
—	On disk	Elongation E.W. suspected.	1 45 0	—	M.	
—	—	Elongation certain.	2 4 0	—	M.	
—	—	Still bright.	2 14 0	—	M.	
—	I. Tr. E.	First contact.	3 48 54	3 50 0	M.	
—	—	Last contact.	3 51 59			
—	I. Sh.	On C.M.	3 47 39	—	M.	No penumbra. Circular and black.
—	IV. on sky	Near conjunction.	1 35 0	—	M.	Very faint.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1899.			h m s	h m s		
Aug. 3	I. Ec. R.	First glimpse.	2 11 44	2 12 14	M.	
—	—	Elongated N.S.	2 12 52	—	M.	
—	—	Fully bright.	2 14 24	—	M.	
—	II. Tr. I.	Well on	4 0 0	—	M.	Very luminous.
Aug. 5	II. Ec. D.	Already faint.	1 29 48	—	M.	
—	—	Gone	1 31 53	1 30 17	M.	
Aug. 10	IV. near	Conjunction	1 35 0 to 2 20 0	—	M.	Very faint, and with a strong blue tinge.
Aug. 11	III. Ec. R.	First glimpse.	1 47 52	1 49 44	M.	
—	—	Fully bright.	2 4 21	—	M.	
Aug. 12	II. Oc. D.	First contact.	1 31 49	1 34 0	M.	
—	—	Gone	1 36 29			
Aug. 27	IV. past	Conjunction	1 5 0 to 2 5 0	—	M.	Faint and blue.
Aug. 28	II. Tr. I.	First contact.	1 10 52	1 10 0	M.	
—	—	On	1 16 47			
Sept. 2	I. Oc. D.	First contact.	—	1 7 0	M.	Missed.
—	—	Gone	1 8 45		M.	
Sept. 3	I. Tr. E.	First contact.	—	0 41 0	M.	Missed.
—	—	Last contact.	0 44 13		M.	
—	I. Sh.	On disk	0 55 0	—	M.	Some distance past C.M., sharp and black.
Sept. 12	III. Tr. I.	First contact.	1 52 59	2 4 0	M.	
Sept. 13	II. Oc. D.	Do.	1 51 17	1 54 0	M.	
—	—	Gone	1 56 12			
Sept. 22	II. Tr.	On disk	1 8 8	—	M.	
—	II. Tr. E.	First contact.	—	1 16 0	M.	Missed in a wisp of cloud.
—	—	Clear	1 18 53		M.	Doubtful, definition tremulous.

PART 5.

The Director requested several of the Members of the Section to note the colours and colour changes during the apparition, and some of the notes furnished by the observers are as follows :—

Mr. Townshend, 1899, *April* 30, $11^h\ 10^m$ λ 240°.—Both great belts brown smoke colour; equatorial zone pale pink. Both poles bluish.

May 3, $9^h\ 20^m$ λ 265°.—S. equatorial belt dark mahogany colour, with a bright rift throughout; N. equatorial belt narrow and greenish yellow tint. Equatorial zone ruddy, especially the

southern section, and gradually fading away into the N. belt, showing no dividing line. Fine equatorial belt grey. S. tropical belt divided from end to end and grey. S. temparate belt same as S. tropical belt. Both poles grey.

May 6, $10^h\ 45^m$ λ 47°.—S. equatorial belt sepia. Following shoulder of bay heaped up to a peak, like a mountain peak, and high. N. equatorial belt pale green and flocculent. Outline of Great Red Spot glimpsed, with greyish centre. Equatorial zone salmon pink, and to the N. melting into the greenish N. belt.

May 26, $11^h\ 5^m$ λ 186°.—Both great belts drab, southern the heaviest. Equatorial zone yellowish. Rifts in belts partake of the general tone of colour, but luminously so.

May 28, 11^h λ 123°.—S. equatorial belt dull olive green; N. equatorial belt dull pale sage green, with horizontal wavy markinge. Equatorial zone pink in centre only, fading into colourless limbs. N. pole heavy grey. An hour previously the equatorial zone was yellow.

June 4, $9^h\ 20^m$ λ 35°.—S. equatorial belt dark slate blue. N. equatorial belt same colour, but less pronounced. Equatorial zone ruddy. Fine equatorial belt seen all the way across the disk, pale grey. At $9^h\ 47^m$ the equatorial zone suddenly changed to a yellow tint, and at $10^h\ 10^m$ it as suddenly changed to a pink tint, and both belts to a mahogany colour. (Mr. Townshend notes that these changes were corroborated by a friend who was with him.)

June 5, 11^h λ 246°.—N. and S. equatorial belts smoky green colour, fading away towards limbs. Equatorial zone pale yellow; fine equatorial belt seen centrally only.

June 6, $9^h\ 25^m$ λ 339°.—S. and N. equatorial belts dull grey; equatorial zone faintly ruddy orange, fading away towards limbs.

June 15, $10^h\ 15^m$ λ 281°.—S. equatorial belt dull pale green, with a luminous pale greenish rift from end to end, and a loop formation centrally of the same colour. N. equatorial belt pale green, with a luminous greenish narrow rift from end to end. Equatorial zone pale yellow. N. pole faintly green.

The pink or ruddy appearance of the equatorial zone remains singularly marked in the region of the Great Red Spot, while the opposite side of the planet assumes uniformly quiescent colours. Mr. Townsend considers the changing colours of the equatorial zone and belts to be due to incandescent vapours of metals.

The Rev. Theodore E. R. Phillips, 1898, *December* 21.—Both equatorial belts reddish chocolate, but the southern belt decidedly the darker of the two. Equatorial zone yellowish orange.

1899, *January* 16.—Both equatorial belts reddish chocolate, other belts grey.

February 27, *March* 20 *and* 22.—Equatorial belts reddish chocolate. Equatorial zone orange.

March 27.—Both equatorial belts a brown red.

April 4.—Belts less strongly coloured, but still reddish.

April 15.—Equatorial belts reddish chocolate.

April 18.—S. equatorial belt decidedly red. N. equatorial belt a slight tinge of purple.

April 19.—S. equatorial belt red. N. equatorial belt very grey without a trace of red.

April 22.—S. equatorial belt of a very deep chocolate red. N. equatorial belt greyish blue.

May 6.—Both belts reddish.

May 23.—S. equatorial belt deep purplish red. N. equatorial belt grey with a tinge of green. Other belts grey. Equatorial zone yellowish orange.

June 3.—S. equatorial belt deep purplish red. N. equatorial belt much greyer, but with a tinge of red.

June 4.—S. equatorial belt very deep purplish red. N. equatorial belt greyish, but with a decided tinge of red. Other belts grey.

Mr. Phillips remarks that observers seem to vary much in their estimation of colour, and some are much more capable of appreciating variations in tint than others. He instances that Mr. Stanley Williams speaks of seeing various features "as all red" which to his eye are all distinctly grey.

The Rev. Robert Killip, 1899, *May* 19.—The N. equatorial belt is still decidedly green to my eye, as is the portion of the S. equatorial belt preceding the hollow beneath the great shoulder.

June 9.—I always see the difference between the N. and the S. equatorial belts. The shade of the former is dirtier, if I may so say, still the greenish nature of it is there.

Mr. Killip adds,—The colour of the N. equatorial belt—though not very marked in the earlier months—was decidedly and always green to my eye later on. The equatorial zone was never without a tinge of orange; while the S. equatorial belt from first to last was of a chocolate hue.

Mr. Ernest Attkins.—S. polar region. Usually of a browny red colour and rather dense.

S. temperate zone. Noted on nine nights as white, and on 26 as yellowish.

S. tropical band corresponded in colour with the S. equatorial belt.

S. tropical zone always brilliantly white.

S. equatorial belt. Almost always duplex, of a marked red tint, which afterwards changed to a golden brown tone. Always darker and denser than the N. equatorial belt.

Great Red Spot. The bay usually perfectly white, the spot itself either a very faint grey or very slightly warm in tone, especially on May 23.

Equatorial zone a most beautiful yellow colour.

Equatorial band seen on a few nights, but generally faint.

N. equatorial belt. On the whole about equal in width to the S. equatorial belt, fainter, but always of the same colour

N. tropical zone. Generally white, but occasionally yellowish,

N. temperate band. Seen on several nights. Usually it partook of the tint of the N. polar region.

N. polar region. On some nights its blue tint was very striking, but it was not always blue. On May 29 and June 16 it was noted as being distinctly brownish red. Very often more grey than blue.

The changes of colour deserve careful and systematic observation.

ARTHUR COTTAM,
Director of the Section.

July 13, 1900.
Watford, Herts.

OBSERVATIONS OF JUPITER, 1899.

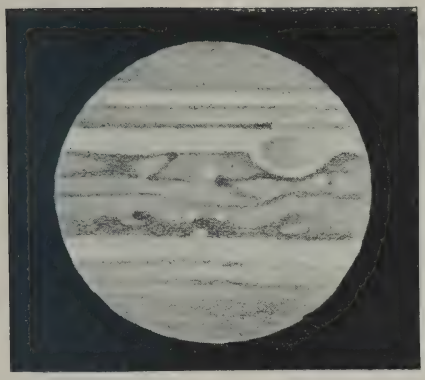


Fig. 1. P. B. Molesworth, 12½ in. Spec.
1899, June 7, 5 h. 57 m. Long. 5°.

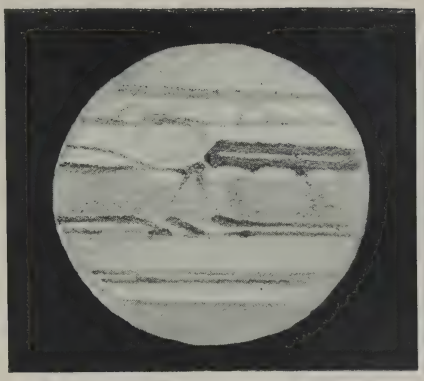


Fig. 2. T. E. R. Phillips, 9 in. Spec.
1899, April 19, 11 h. 50 m. Long. 50.1°.

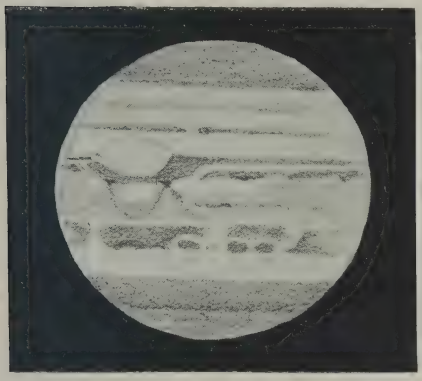


Fig. 3. Scriven Bolton, 4⅛ in. O.G.
1899, June 16, 9 h. 45 m. Long. 54°.

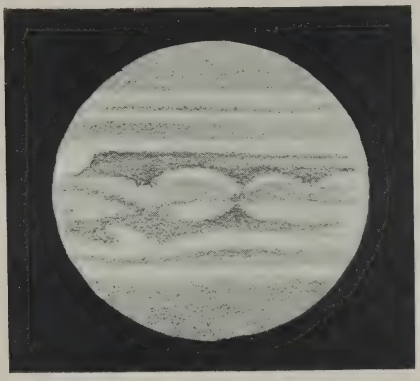


Fig. 4. W. Anderson, 5 in. O.G.
1899, May 9, 9 h. 20 m. Long. 87°.

Fig. 5. E. Attkins, 6½ in. Spec.
1899, April 17, 13 h. 2 m. Long. 153°.

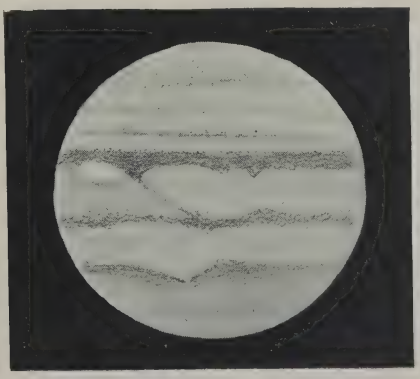


Fig. 6. W. J. Hall, 4⅞ in. Spec.
1899, May 31, 9 h. 30 m. Long. 161°.

OBSERVATIONS OF JUPITER, 1899.

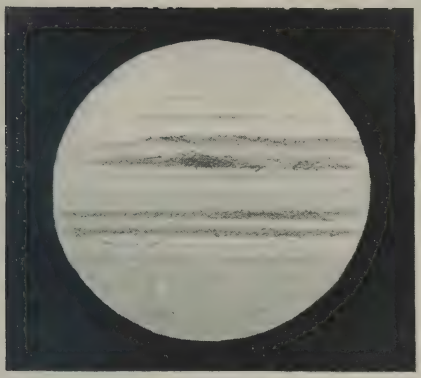


Fig. 7. W. R. Waugh, $4\frac{1}{2}$ in. O.G.
1899, June 16, 10 h. Long. 220°.

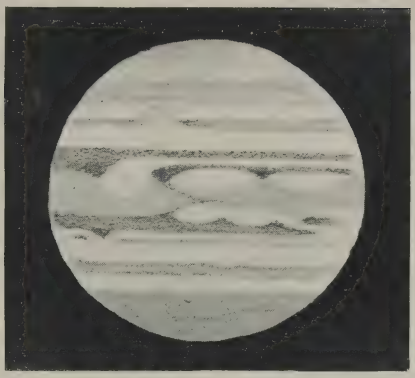


Fig. 8. T. E. R. Phillips, 9 in. Spec.
1899, March 22, 14 h. 5 m. Long. 238°.

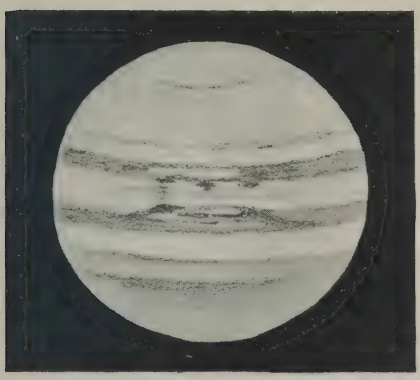


Fig. 9. H. J. Townshend, 10 in. Spec.
1899, June 5, 11 h. Long. 246°.

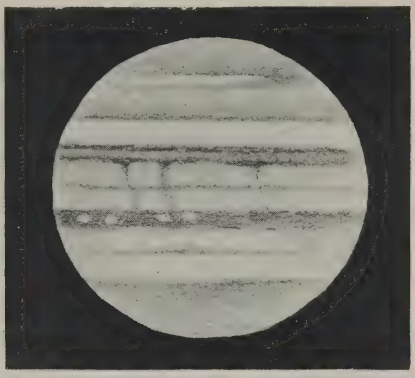


Fig. 10. Robert Killip, 5 in. O.G.
1899, June 3, 9 h. 45 m. Long. 260°.

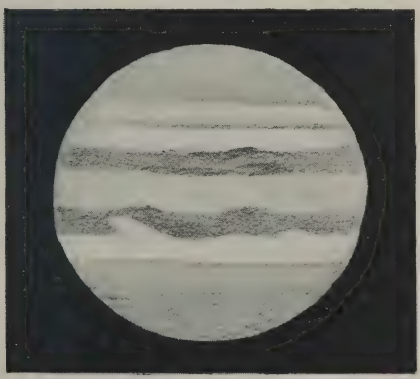


Fig. 11. J. H. Bridger, 4 in. O.G.
1899, May 27, 10 h. 5 m. Long. 300.5°.

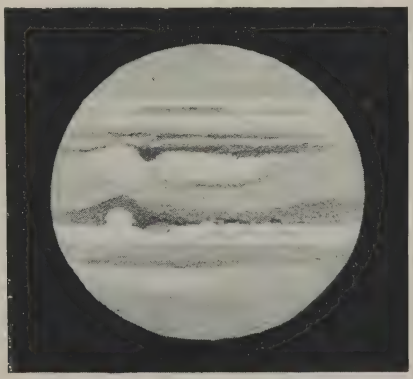


Fig. 12. Charles F. Smith, $5\frac{1}{4}$ in. Spec.
1899, June 13, 10 h. 25 m. Long. 348°.

SECTION FOR THE OBSERVATION OF METEORS.

DIRECTOR—W. F. DENNING, F.R.A.S.

REPORT OF THE SECTION, 1899.

Introductory.

This year's report is drawn up on similar lines to the reports of preceding years. Several of the periodical showers, such as Quadrantids, Lyrids, Orionids, and Geminids were very inadequately observed in 1899 owing to cloudy weather and moonlight. Of the Leonids, much was expected and little realised. The shower came, it is true, but only in the strength of an ordinary year, though the earth should have passed through that rich region of the orbit just following the parent comet, for the latter must have returned to perihelion in the spring. Next November promises to display the missing shower, unless, indeed, the dense part of the stream has been perturbed and is enabled to evade contact with the earth, which seems quite possible. The August Perseids were watched under the best observational conditions, though the return was not of exceptional strength, and the slow-moving meteors of Biela's comet formed a marked shower on November 23 and 24, though the phenomenon could not rank with the displays of 1872 and 1885. A large number of fireballs have been observed during the year, but the observations of some of these were not sufficiently exact for their real paths to be computed. Simultaneous watches have been arranged at various periods during the year, and a number of meteors have been recorded by two or more observers. The particulars of these are given in a tabulated form. They are regarded as of considerable interest, not only as affording useful evidence as to the heights at which these bodies are consumed, but as giving the radiants both of active and well-known systems, and of very weak showers which have escaped other means of determination. Interim reports have been published as follows:—August Meteors, "Journal," Vol. IX., p. 429; November Meteors, Vol. X., p. 56; and to these the student is referred for details supplementary to those appearing in the present report. The Section numbers about 20 Members. Messrs. Astbury, Besley, Bridger, and King have sent in monthly summaries of their observations, which are of considerable fullness and value. The Director has also had the advantage of receiving a large number of observations from Prof. A. S. Herschel, at Slough, and of comparing notes with him. Acknowledgment should also be made to Lieut.-Col.

1 p. 148.

Tupman, who has kindly computed the real paths of six bright Perseids seen in August last.

Bristol,
March 18, 1900.

W. F. DENNING,
Director.

Record of Meteoric Observations.

QUADRANTIDS.

Moonlight and stormy weather almost obliterated this display. Mr. J. H. Bridger, at Farnborough, watched on January 1 from 7.30 to 8.30 and noted two Quadrantids and five other shooting stars. Mr. T. W. Backhouse reports that the sky was unfavourable. On January 1, in 37 minutes he noted five Quadrantids. The Rev. T. E. R. Phillips, Yeovil, observed four meteors, including three pretty bright Quadrantids, in a quarter of an hour on evening of January 2. Mr. A. King, Leicester, watching at intervals before 9.30, saw five meteors on January 1, but the sky was overcast on January 2. The Rev. S. J. Johnson, of Bridport, noted six meteors on January 2 following same direction (Quadrantids) between 6^h 50^m and 7^h 20^m, but in the next half an hour not one was seen. At Bristol, the night of January 2 was stormy, and only two Quadrantids were seen through clear openings at 6^h 14^m and 7^h 40^m.

LYRIDS.

Mr. Bridger, on April 11, saw six meteors between 9^h and 11^h 30^m; on April 12 not one was seen in $1\frac{1}{2}$ hours between 9^h and 11^h. Later nights were unfavourable, and very few meteors observed. Prof. Herschel watched for the shower on the nights of April 16, 17, and 19, but saw very little indication of it, and there appeared to be very few meteors from the minor radiants of this epoch. There was, however, a tolerably active shower in Canes Venatici. Mr. Besley reports that April 19 was the only date which offered a prospect for making observations, but that he saw no meteors in about $1\frac{1}{2}$ hours. Mr. Astbury writes that on April 18 the sky was fairly clear, April 19 bright moonlight, April 20 raining, April 21 cleared up after a day's rain, and a few meteors were recorded, but there was no sign of the Lyrid shower.

MAY AQUARIDS.

During the period May 3–7 the sky was beautifully clear, and Prof. Herschel registered 85 meteors in 16 hours of observation. Several of the long-pathed Aquarids were seen just before daylight. Prof. Herschel has combined these observations with a series which he obtained on similar dates in 1894, and deduced a considerable number of radiants (*see* list) with unusual precision. Mr. E. R. Blakeley, of Dewsbury, watching on May 3–7, counted 67 meteors in about $9\frac{1}{2}$ hours, but saw no Aquarids. He found meteors exceptionally numerous on May 7 between 11^h and 11^h 30^m.

JULY METEORS.

Between July 28 and August 1 Mr. King registered 76 meteors, but these included only three Aquarids. Mr. Astbury, Mr. Bridger, and others obtained a large number of observations

at this period, but the Aquarids were not strongly represented. At Bristol, eight members of this shower were charted between July 30 and August 13. A few early Perseids were also seen by the various observers during the last week in July.

AUGUST PERSEIDS.

The weather proved excellent on and after August 9, and the moon being absent, this well-known stream was witnessed to the best advantage. The following are some of the summarised results :—

Date.	Interval of Observation.	Duration.	All Meteors.	Perseids.	Radiant.	Observer.
	h m h m	h m			α° δ°	
Aug. 1 -	9 0—11 10	2 10	18	5	30 +54½	J. H. Bridger, Farnborough.
„ 2 -	10 18—11 29	1 11	11	2	—	
„ 4 -	9 40—11 7	1 27	8	1	—	
„ 8 -	9 52—10 48	0 56	5	1	—	
„ 9 -	10 45—12 30	1 45	29	15	41 +55½	
„ 10 -	9 43—11 47	2 4	46	21	43 +56	
„ 11 -	9 15—12 0	2 45	59	29	45 +57	
„ 12 -	10 6—11 55	1 49	34	12	46 +56½	
„ 14 -	9 20—11 51	2 31	19	5	52 +58½	
„ 10 -	10 35—15 0	4 25	86	54	45½+58½	W. E. Besley, Clapham, London, S.W.
„ 11 -	10 5—11 13	1 8	15	8	45 +57	
„ 12 -	10 25—12 15	1 50	30	15	48 +58	
„ 14 -	10 50—13 0	2 10	24	5	50 +58	
„ 6 -	10 0—12 0	1 45	18	6	40 +55	W. F. Denning, Bristol.
„ 9 -	10 0—13 0	2 0	38	26	44 +57	
„ 10 -	10 0—13 30	3 0	91	72	44 +57	
„ 11 -	10 0—13 0	3 0	90	69	46 +57	
„ 12 -	10 0—13 0	3 0	62	43	48 +57	
„ 13 -	10 0—12 30	2 0	23	10	49 +58	
„ 14 -	10 0—12 30	2 30	29	12	50 +56	
„ 16 -	10 30—14 30	3 30	43	7	53 +57	
„ 10 -	9 6—14 36	5 30	104	84	45 +56	E. M. Antoniadi, Juvisy, France.
„ 11 -	9 6—14 36	5 30	138	116	46½+56	
„ 12 -	9 6— 9 56	0 30	7	6	46 +57	
„ 13 -	9 36—11 36	2 0	22	15	48 +55	
„ 8 -	9 50—11 50	2 0	21	—	—	A. King, Leicester.
„ 9 -	9 50—13 5	3 15	55	7	44½+57	
„ 10 -	10 10—14 10	4 0	67	29	45 +57	
„ 11 -	10 25—14 0	3 35	84	17	46 +57	
„ 12 -	11 15—13 30	2 15	35	7	48 +58	
„ 13 -	10 30—12 30	2 0	25	5	49 +57	
„ 14 -	9 45—12 0	2 15	19	8	49 +58	

Mr. T. W. Backhouse, at Sunderland, was struck with the large proportion of bright meteors. This could not be accounted for by the misty weather. Of 84 meteors seen at this epoch he recorded 1 = ♀, 3 = ♃, 8 = Sirius, 14 = mag. 0, and 7 = mag. 1. On August 10, watching between 10^h and 13^h 30^m for a discounted period of 1^h 53^m he saw 36 meteors (31 Perseids). On August 11, 9^h 58^m to 13^h 59^m (period 2^h 6^m) he noted a precisely similar number, so the maximum was indicated for August 10.

Mr. T. H. Astbury, at Wallingford, usually watched between 10^h and 11^h. In this hour he saw the following numbers of meteors, August 10, 34, August 11, 18, August 12, 30, August 13, 18, and August 14, 17. Of 82 meteors which he actually recorded between August 8–14 the great majority were Perseids, and the radiant appeared very diffuse. On August 10 several Cygnids were seen, and on later nights a few paths indicated a radiant near γ Andromedæ.

Prof. A. S. Herschel counted 104 meteors on August 10 11^h 10^m to 14^h 35^m and mapped 65 of these. The sky was clear and dark, and the horary rate = 30 or 42, if time is allowed for writing notes, &c. On August 11, 11^h to 12^h he saw 22 meteors, then clouds intervened. Between $12\frac{1}{2}^h$ and $13\frac{1}{2}^h$ there were 15 meteors, so that the strength of the display was evidently declining.

Mr. H. Corder, at Chelmsford, was watching for some hours on August 10, and counted 116 meteors.

Mr. Ivor F. H. Carr Gregg observed the shower from the Malvern Hills. It seemed about equally rich on August 10 and 11, and both nights were cloudless. Two observers obtained the following numbers:—

	h	m	h	m	
August 10 -	12	15 to	15	15.	127 meteors
,, 11 -	11	0 to	16	0.	210 meteors

Magnificent meteors as bright as or brighter than ♀ were seen on August 10, 13^h 55^m, August 11, 13^h 44^m, and 13^h 57^m. These objects lit up the sky and left streaks enduring for about half a minute. The time of greatest frequency was August 11, 13^h to 13^h 15^m when 23 were seen, and the rate was 92 per hour.

Mr. W. H. Milligan, of Belfast, has published the results of his observations as follows: On August 4 he saw some meteors, including a stationary one from the radiant in the position* near η Peresi, which is really six degrees W. of its real place on August 4. On August 8 he counted 10 Perseids with diffuse radiation. On August 10 and 11 the meteors fell pretty constantly, but they did not seem so strong as in previous years. Maximum was thought to occur on August 11, 11^h to 11^h 30^m local time, hourly number about 60. Display fell off on August 12, and on August 14 everything was much as usual. The sub-radiants were at 10° + 38° and 70° + 55°.

The Rev. W. R. Waugh watched for about two hours on July 31, August 4, 9, and five following nights, seeing about 15

* Mr. Milligan has in several years observed the Perseid radiant at about 44" + 57° August 3–6. Its correct position on August 4–5 is $38\frac{1}{2}$° + $55\frac{3}{4}$°. the Director is entirely at a loss to explain the cause of this discordance.

Perseids and some other meteors, including several from a radiant near α Persei.

Mr. G. Carslake Thompson, of Cardiff, made a series of observations of the Perseids on August 10, 11, and 12. The number of meteors counted on the three nights was 58, 174, and 27 respectively. A full account of his observations appears in the Cambrian "Natural Observer."

Mr. C. L. Brook, of Meltham, near Huddersfield, saw 20 meteors on August 10, $9^h\ 50^m$ to 11^h. On August 11, 14 were seen in the hour from $9^h\ 55^m$ to $10^h\ 55^m$.

Briefly reviewing the results, it may be said that the shower was not a brilliant one, certainly not so rich as on August 11, 1898, but it was seen to great advantage in the clear moonless skies which prevailed just at the important time. The easterly motion of the radiant was amply corroborated by a comparison of the radiants determined on the several nights of observation. Some of the most brilliant Perseids were recorded by several observers, and their real paths are included in the table. In 1899 the maximum was variously estimated as occurring on August 10 and 11, and there seems to have been very little difference in the relative strength of the shower on the two nights. Remembering that the maximum occurred in 1898 on August 11, and that 1900 is not a leap year, we must expect the Perseids to be more numerous on August 11 than on August 10 in future years.

Of the minor showers a considerable number manifested themselves. Prof. Herschel and Mr. King saw a fair proportion of Camelopardids, while the latter and Mr. Besley detected active showers in Cassiopeia. At Bristol the most prominent shower was at $277^\circ + 70^\circ$, and there were also definite radiants near β Piscuim, κ Cephei, o Draconis, &c. The Director finds many of the same streams exhibited every year, in fact they appear to be as certain in their recurrences as the Perseid shower itself. 1893, like 1899, was a very auspicious one as regards weather conditions for the Perseids, and some of the secondary showers recognised on the former occasion at Bristol compare with the results in 1899 as under :—

1893.		1899.	
No. of Meteors.	Radiant.	Radiant.	No. of Meteors.
8	$19^\circ + 29^\circ$	$16^\circ + 31^\circ$	4
5	$41^\circ + 23^\circ$	$40^\circ + 21^\circ$	5
11	$48^\circ + 44^\circ$	$47^\circ + 44^\circ$	6
6	$310^\circ + 77^\circ$	$315^\circ + 77^\circ$	10
6	$347^\circ \pm 0^\circ$	$345^\circ \pm 0^\circ$	9

But in 1893 there were notable showers of Cygnids ($292^\circ + 53^\circ$, 28 meteors), and η Cepheids ($311^\circ + 62^\circ$, 17 meteors) apparently wanting in 1899, and the shower of ϕ Draconids, seen in the latter year, was absent in 1893. No doubt there are variations in

strength from year to year, and the feebleness of certain displays often enables them to evade detection.

ORIONIDS.

The moon was full, and very few of these meteors were noticed. Some interesting observations of meteors were, however, secured by Prof. Herschel, and Messrs. Astbury, Bridger, and King during the first half of October. These sufficiently show that the Orionid shower commenced at an earlier date than usual, and yielded some brilliant meteors at a time before it is customary to expect them. On October 10 a Venus-like Orionid, was recorded by Mr. Bridger, and on the following night Prof. Herschel detected the on-coming of the shower. In half an hour of pretty clear sky he mapped two Orionids indicating the radiant at $92^\circ+17^\circ$. On October 16 another brilliant member of the same system was seen by Mr. Davies at Chichester, and these various objects are included in the list of bright meteors. During October, Mr. Bridger watched for nearly 15 hours (13 nights), and counted 83 meteors, but there were only two Orionids amongst them. Near the time of the maximum, however, (October 18–22), few observations were obtained. Moonlight, cloudy or misty weather, often practically obliterate a shower which, under the best possible circumstances, would offer a fairly conspicuous display. In judging of the character of an event of this nature we must always carefully consider the conditions which greatly influence its visible aspect. Though very little was noticed of the Orionids of 1899, they might have formed an average display had it been possible to view them without hindrances.

LEONIDS.

Another failure! Yet it was thought that the display of 1899 would more than compensate for the weak showers of 1897 and 1898. The failure is much deplored in view of the universal effort to witness the phenomenon and secure useful observations. No meteoric event ever before aroused such an intense and widespread interest, or so grievously disappointed anticipation. The scientific journals and newspapers all contained references to the subject, and the occurrence was predicted in such confident terms to take place that the public became enthusiastic, and looked forward to its appearance as a certainty. Many people regard the prescience of the astronomer as something marvellous, he can foretell the moment of an eclipse that will occur generations hence, and no thought of questioning either his accuracy or veracity ever enters their heads. Thus everyone expected that when they looked up to the sky on the night of November 14–15 they would see it full of meteors. But the fiery storm did not appear. The firmament, with its glittering stars and silver moon, was just as still as on an ordinary mid-November night. Only now and then, indeed, a shooting star rapidly streaked along the sky to prove that the Leonids were present in a weak and scattered shower in place of the dense and brilliant display that had been awaited. The finest celestial sight of a generation had failed to come at its appointed time, and the disappointment was all the keener in some quarters from the impression which prevailed that another chance of witnessing it would not occur until 1933.

A very large number of observations have been received by the Director. They show that elaborate preparations had been made to suitably record the event. But from stations both at home and abroad—from America, India, Australia, Norway, Russia, China, &c.—the story of meagre results is much the same. A few of the Leonid meteors, with their rapid flights and luminous streaks, were seen shooting from the familiar configuration of stars forming "the sickle," but there was no sign of a grand display anywhere. The photographic method, of which so much was expected, furnished little but blanks owing to the paucity of bright meteors, and possibly the prevalence of moonlight may have exercised a bad effect.

Some of the results have been already tabulated in the interim Report ("Journal," Vol. X., p. 56), and selections from others are given here. The summary is by no means complete, but it is thought that no important end would be gained by quoting a large mass of results of negative character. To the numerous Members of the Association and others situated in various parts of the world who, though not belonging to the Meteoric Section, have supplied descriptions; the Director begs to tender his sincere thanks.

Mr. H. G. Tomkins writes from Allahabad, India, enclosing a valuable digest of observations, both in 1898 and 1899. He says that a party of 11 men volunteered for the work, and that they were carefully instructed as to details. The results obtained were as under:—

Date.	Hours of Observation.	Leonids.	Other Meteors.	Remarks.
1899.	h h			
Nov. 7	14 to 16	11	37	Leonids small; sky clear.
„ 8	14 „ 16	12	20	One large, others small; sky misty.
„ 9	14 „ 16	15	1	Seven bright; sky clear.
„ 10	14 „ 16	6	25	Small; sky clear.
„ 11	14 „ 16	15	32	Three bright; sky clear.
„ 12	14 „ 16	15	48	One bright; sky misty.
„ 13	$10\frac{1}{2}$ „ 13	3	5	Sky clear.
„ „	13 „ $15\frac{1}{2}$	17	28	„
„ „	$15\frac{1}{2}$ „ $17\frac{1}{2}$	30	5	„
„ 14	$10\frac{1}{2}$ „ 13	5	Not recorded.	Sky misty.
„ „	13 „ $15\frac{1}{2}$	17	4	Partly cloudy.
„ „	$15\frac{1}{2}$ „ $17\frac{1}{2}$	58	26	„
„ 15	$10\frac{1}{2}$ „ 13	1	4	Sky clear.
„ „	13 „ $15\frac{1}{2}$	13	1	„
„ „	$15\frac{1}{2}$ „ $17\frac{1}{4}$	38	4	„
„ 16	14 „ 16	1	Not recorded.	Cloudy.
„ 17	14 „ 16	8	„	„
„ 18	14 „ 16	1	2	Sky clear.
„ 19	14 „ 16	2	4	„
„ 20	14 „ 16	0	2	„
„ 21	14 „ 16	2	4	„

Mr. Tomkins notes that the meteors generally were very small. This may have been partly due to moonlight, but even after the moon had set very few of those seen were brighter than 3rd mag. In point of numbers the shower was distinctly inferior to that of last year; indeed so poor was it that he did not think it worth while to expose his cameras, although he had six in readiness.

Mr. Tomkins has drawn up the following table showing a comparison of the results in 1898 and 1899. In 1898 the watch was kept in Madras, in 1899 at Bombay.

Date.	Hours.	1898.		1899.	
		Leonids.	Sky.	Leonids.	Sky.
	h h				
Nov. 7 -	14 to 16	3	Cloudy -	11	Clear.
„ 8 -	„	0	„ -	12	Misty.
„ 9 -	„	6	Not stated -	15	Clear.
„ 10 -	„	21	„ -	6	„
„ 11 -	„	28	„ -	15	„
„ 12 -	„	28	„ -	15	Misty.
„ 13 -	10½ to 13	23	Cloudy -	3	Clear.
„ 13 -	13 to 15½	0	„ -	17	„
„ 13 -	15½ to 17½	33	Clear -	30	„
„ 14 -	10½ to 13	0	Cloudy -	5	Misty.
„ 14 -	13 to 15½	101	Clear after 14th.	17	Partly cloudy.
„ 14 -	15½ to 17½	151	Clear -	58	„
„ 15 -	10½ to 13	60	„ -	1	Clear.
„ 15 -	13 to 15½	166	„ - -	13	„
„ 15 -	15½ to 17½	216	„ -	38	„
„ 16 -	14 to 16	38	„ - -	1	Cloudy.
„ 17 -	„	18	„ -	8	Clear.
„ 18 -	„	15	„ - -	1	„
„ 19 -	„	17	„ -	2	„
„ 20 -	„	16	„ - -	0	„
„ 21 -	No watch kept.		—	2	„
	Total Leonids	940		270	

In 1899 the maximum was distinctly marked for November 14, $16^h\ 50^m$. The hourly rates on November 14 and 15 were as follows:—

	h h		
November 14 -	15 to 16	- 7	Leonids.
	16 to 17	- 43	„
	17 to 17¼	- 13	„
		63	„
	h h		
November 15 -	15 to 16	- 9	Leonids.
	16 to 17	- 20	„
	17 to 17¼	- 10	„
		39	„

Mr. Tomkins adds that meteors from other radiants were carefully excluded from the Leonids. The Taurids and Orionids were pretty active, most of the other meteors coming from these radiants. The observations were undertaken to determine the number of meteors and the time of their maximum abundance. It was intended to utilise photography in getting the position of the radiant point, but the poorness of the display prevented this being accomplished. The watches on November 13 to 15 inclusive were kept by three observers; two of them facing opposite directions (E. and W.) kept count while the third called time every five minutes.

The Rev. Ellis G. Roberts sends observations made by members of the staff and undergraduates of Noble College, Masulipatam, South India. The shower seems to have been at its thickest on November 15, $15^h\ 45^m$ to $17^h\ 15^m$, local time. 15 Leonids of about mag. 1 were seen in this half an hour, ending November 15, 17^h. Mr. Ellis sends a list of the more brilliant Leonids, and has been training his native assistants to take observations. He says they are very keen on it, but require a good deal of guidance.

Capt. P. B. Molesworth forwards some interesting notes from Trincomali, Ceylon. He attempted to photograph the swarm in the open sky in the moonless nights before and after the shower. He also made an effort to obtain the place of the radiant photographically by cameras equatorially mounted and pointed to the sickle, "and to obtain visual observations as well."

In endeavouring to photograph the swarm, the instrument used was a 6-in. Marion portrait lens of 36-in. focus, mounted on a $12\frac{1}{2}$-in. Calver equatorial, which was employed as a guiding telescope. Dr. Downing's ephemeris of the group was used, and in the moonless period just preceding the shower-date seven photographs were taken. Cloudy weather prevented any photographs being secured after the shower. No trace of the swarm could be detected on any of the plates. On November 15, after the moon had set, an attempt was made to photograph the radiant, but no meteor trails were detected upon any of the plates after their development. Capt. Molesworth's visual observations were somewhat fragmentary, as he had no assistant, and was much occupied with his instruments. On November 8, $14^h\ 40^m$ to $16^h\ 52^m$, two doubtful Leonids were seen. On November 9, 16^h to $16^h\ 50^m$, several meteors were observed, of which two were almost certainly Leonids. November 10, $14^h\ 20^m$ to $16^h\ 50^m$, another clear night, and two further Leonids appeared. Little was seen on the few subsequent nights. On November 15, $15^h\ 15^m$ to $16^h\ 50^m$, 15 Leonids and six unclassed meteors were noted, but during the first half-hour of the watch there were drifting clouds. In concluding his report, Capt. Molesworth says his observations were, speaking generally, a failure, but the nights of November 13 and 14 were too cloudy to make observations.

At the Astronomical Observatory of Zosè, Shanghai, China, the sky was beautifully clear on the nights of November 14, 15, and 16. About 60 Leonids were seen on the three nights, and they were most numerous on November 14 at about 17^h, local time. Brilliant Leonids were observed on November 14, $14^h\ 7^m$, and November 15, $15^h\ 40^m$. The latter crossed Sirius and went

25° beyond that star, leaving a long streak, and finally bursting. All the Leonid meteors radiated from within the loop of the "Sickle."

Mr. W. A. Parr, writing from Florence, states that he was unable to detect any of the Leonids, but that Signor Abetti, of the Arcetri Observatory, informed him that on November 14, 16^h to 17^h, local time, 10 bright Leonids were observed. On November 15 the sky was veiled in fog.

The Rev. A. L. Cortie, S.J., reports from Stonyhurst College Observatory that the night following November 14 was overcast. November 15 was fairly fine, and a continual watch of the S. and E. sky was kept from 10^h to 18^h 45^m. Only 22 meteors were seen, and of these 14 were noted during the interval from 14^h 28^m to 15^h 48^m. Ten of the meteors were almost certainly Leonids. They were swift, of a greenish tint, and had long paths. The brightest meteor observed during the night appeared at 16^h 49^m. It outshone Venus, and the beautiful emerald green streak it left behind was visible 12 seconds after the disappearance of the nucleus. Path, $144\frac{1}{2}° + 24\frac{1}{2}°$ to $109\frac{1}{4}° + 28°$. As to the Leonid radiant, six of the meteors radiated from a point near ϵ Leonis, while two others intersected near γ Leonis. Four of the tracks point to a radiant near α Orionis, and five others were sporadic.

Prof. E. E. Barnard, of the Yerkes Observatory, writes that they were prepared with 16 cameras and Mr. Ritchey's 24-in. reflector, to take photographs of the Leonids, but solid clouds prevented their seeing anything of the shower.

Mr. J. Evershed, of Kenley, Surrey, watched on November 14, 13^h 25^m to 14^h, and saw two Leonids. Between 15^h and 16^h, there were four Leonids. On November 15, the weather was generally unfavourable, but from 16^h 30^m to 16^h 50^m, three Leonids were noted through breaks in the clouds. So far as his observations enabled him to judge, he thought there were no more Leonids visible than during an average return of the shower, and certainly less than at an average display of Perseids.

Messrs. Wiblin, Jones, Pereira, and Alderson, undergraduate members of Jesus College, Oxford, watched from the college quadrangle on November 14, 15^h 15^m to 18^h 15^m, and saw about 50 meteors, which, for the most part, radiated from the "Sickle" of Leo, only about half-a-dozen being from other constellations. The majority were in the N. and passed through Ursa Major. The meteors were most frequent and brilliant between 17^h 30^m and 18^h. At 17^h 38^m, a large and very brilliant meteor of a peculiar violet colour passed from near Leo to Auriga, leaving a nebulous train for three minutes.

Mr. A. King, Leicester, saw 10 Leonids on November 15, 13^h 15^m to 17^h 15^m, and found the radiant at $151\frac{1}{2}° + 22°$. The horary number was only 2·5, but many small meteors probably escaped detection in the moonlight.

Mr. J. H. Bridger, of Farnborough, reports that on November 14, stars to the 2nd or 3rd mag. were visible in early part of the night, but that not a single meteor was seen. On November 15, he was on the look out after 11^h, but the clouds never

broke until 17^h, when there was just enough clear sky to show that no great shower was in progress.

Mr. Ivor F. H. Carr Gregg, of Great Malvern, saw the first Leonid on November 10, at about $12^h\ 40^m$. On November 14, he watched at intervals between 12^h and 18^h, and counted 35 meteors, of which 32 were Leonids.

Mr. T. H. Astbury, of Wallingford, in about 90 minutes of perfectly clear sky on November 14, $16^h\ 3^m$ to $17^h\ 53^m$, saw 37 meteors, including 31 Leonids. The latter generally had a brilliantly white nucleus with a streak of bluish green which appeared to open out slowly, widest at middle of their length, about one second after the nucleus had disappeared. Another point noted was that the streak usually fell short of the point where the head vanished. The average duration for the meteor would be about three-eighths of a second, but several of the streaks lasted quite 10 seconds. The meteors were bright, and mostly 1st or 2nd mag. A fine Taurid or Arietid brighter than 1st mag., was recorded at $17^h\ 8^m$, with a path from $142° - 11°$ to $162° - 16°$. At 17^h, the Zodiacal light was well seen; poorly defined, but extending some degrees further W. than β Virginis.

Prof. A. S. Herschel, of Slough, only mapped five Leonids on the nights from November 12–16, the weather being very unfavourable. He saw 60 non-Leonids between November 6–16, and has published a full description of these observations in "Nature," Vol. 61, p. 225.

Sir W. J. Herschel, of Littlemore, near Oxford, watched the sky on November 14, $13^h\ 15^m$ to $18^h\ 15^m$, and with a small party of assistants counted 62 Leonids and 40 non-Leonids. The former were increasing at the end of the watch, and the maximum was either attained or immiment. At $17^h\ 40^m$, a brilliant meteor traversed a path from $163° + 63°$ to $72° + 66°$, and left a streak for five minutes (*see* "Journal," British Astronomical Association, Vol. X., p. 59, and "Nature," Vol. 61, p. 223).

Mr. T. W. Backhouse, of Sunderland, made observations on November 8, 10, 11, 13, 14, and 15, but only five Leonids were recorded. On November 15, between 10^h and $18^h\ 26^m$, the sky was watched at intervals, amounting to about two hours, but only 10 meteors appeared, and of these four were Leonids. The display was evidently very weak, and moonlight and other hindrances served to obscure it.

The Rev. R. Killip, of St. Anne's-on-Sea, organised a small band of watchers, and the sky cleared on November 15 at 13^h. Between $15^h\ 30^m$ and 18^h, 23 Leonids were seen including very brilliant ones at $16^h\ 43^m$ and $16^h\ 47^m$. The latter was as bright as Venus, and left a greenish blue train for two minutes. Mr. Killip saw the peculiar arc of light described by Mr. Baxendell, at Southport, on the morning of November 16, and quoted in the Interim Report ("Journal," Vol. X., p. 60). The former says it was visible at about $12^h\ 20^m$, and it was from first to last more than slightly curved. Indeed, when first noticed, so archlike was the phenomenon, that for the moment it was thought to be a lunar rainbow. It was certainly an extraordinary spectacle, whatever its cause. Mr. Killip says, "I cannot confirm Mr. B. that its "direction was from S.W. to N.E., for, although we watched it

" until nearly 14^h, it lay towards the N.W. from the E. It had " a slow movement northwards, and faded away very gradually. " It was, as Mr. B. says, broader at one end (E.) than the other, " and in some respects resembled a comet, only that it was too " arched. There was occasionally the faintest trace of colouring, " viz., a tinge of red, and once, at least, a suspicion of green. " We remarked to each other several times that it could be no " mere cloud effect."

Mr. W. C. Tetley, of Aspley Guise, Beds., counted 29 meteors on November 14, between midnight and dawn, and saw the fireball which appeared at $17^h\ 40^m$. He gives the point of its disappearance as $61\frac{1}{4}° + 24°$, and describes the path of the meteor as making an angle of 75° with the line joining α Tauri and the Pleiades. This object was also seen at four different places in or near Oxford, and also by the Rev. T. E. R. Phillips, at Yeovil. The real path of this brilliant meteor is given in the table.

Mr. G. Holland, of Eccles, in conjunction with 15 other observers, watched the sky on November 15, $13^h\ 10^m$ to $15^h\ 10^m$. There were three photographer's in charge of four cameras, and 11 of the observers were employed in counting the meteors as they appeared in various parts of the sky. The total number enumerated was 59 in the two hours. The photographic results were nil.

Dr. R. J. Ryle, of Brighton, on November 14, $14^h\ 30^m$ to 18^h, saw 28 meteors, of which five or six were about 1st mag. Some of the meteors were white, others decidedly greenish white, others again, yellowish with ruddy tinge. The brightest meteors were distant from the radiant, and whereas those near the radiant were generally greenish white those most distant from it were ruddy. Most of them left streaks, but none lasted more than three seconds. Twenty-four of the 28 meteors seen were directed from the sickle of Leo. The tendency of the meteors seemed to be to occur in couples.

Mr. J. E. Clark, of S. Croydon, watched on November 13, $17^h\ 8^m$ to $17^h\ 50^m$, and saw seven Leonids. On following nights the weather was cloudy, and no meteors seen. The radiant on November 13 appeared to be as nearly as possible half-way between γ and ζ Leonis.

Mr. N. Maclachlan, of Largs, Ayrshire, looked for the shower on November 14, $16^h\ 20^m$ to $17^h\ 20^m$, and sends a list of 16 meteors (12 Leonids) observed. At $16^h\ 50^m$, he recorded a stationary Leonid. It blazed out like a 2nd mag. star between μ and ϵ Leonis, and lasted one second. The Leonids were swift, and several left trails.

Mr. Robert Service, of Dumfries, states that the night of November 14 was overcast over the greater part of Scotland, except for about an hour before sunrise. Only a score or less of meteors were seen. On November 15 the sky at Dumfries cleared at 13^h, and he noticed 20 meteors (15 Leonids) during the night. The sky was not favourable, having that gray appearance through which it is difficult to see the stars.

Mr. A. R. Schutz, of Worthing, Sussex, appears to have had better success than most of the observers. He says " on " November 13 we had some six or seven stragglers. On

"November 14, between 15^h and 18^h, he saw *not less* than 200, "all Leonids." November 15 was cloudy. Mr. Schutz gives no details as to the number of observers or method of counting, It seems probable that his figures are merely a rough estimation.

Mr. A. C. Allen, of Eccleshall, Staffs, reports that on November 14, $16^h\ 30^m$ to $18^h\ 45^m$, he counted 19 Leonids and 11 other meteors. One magnificent Leonid appeared at $16^h\ 51^m$. It disappeared halfway between η and δ Hydræ, leaving a bright trail first curved downward and then seemed to roll itself up, and then remained a stationary cloud visible for full 3 minutes at $127° + 4°$.

Mr. J. H. Pledge, of London, N.E., watched a partially obscured sky on November 13, 12^h to $15^h\ 33^m$, but counted only nine meteors. On November 14 the sky was overcast. On November 15 fog prevailed, and only four meteors appeared between $12^h\ 57^m$ to $13^h\ 33^m$, soon after which all celestial objects were hidden.

Mr. J. A. Greenwood, observing near Chichester, registered about a dozen Leonids on November 14, 14^h to $15^h\ 13^m$. They were tolerably bright meteors, comparable to Regulus, and with paths radiating from the centre of the "Sickle."

The Director's results were practically nil on the important night of November 14, as the sky was cloudy. Mr. Besley, at London, Rev. T. E. R. Phillips, at Yeovil, Mr. Arthur Mee, Cardiff, Rev. S. J. Johnson, Bridport, Mr. P. M. Ryves, Weybridge, and others, were equally unsuccessful owing to the weather, which quite obliterated the display.

Briefly reviewing the results, it is certain that the first Leonids were seen on November 8, the last probably on November 19. The maximum, such as it was, occurred before daylight on November 15. The shower was less rich than in 1898, and not so strong as an average display of Perseids. The Leonid returns of 1879 and 1888, when the parent comet was not far from aphelion, were probably quite as rich as the shower of 1899, though it recurred only a few months after the comet had passed through perihelion. It appears likely that the stream has been disturbed since its return in 1866–68 by the action of Jupiter and Saturn, but there is sufficient doubt in the matter to encourage observers to look again for the shower next November. There will be moonlight, but our satellite being near her last quarter, it will not afford such a serious hindrance as it did in 1899. When we remember that there were brilliant displays in 1866, 1867, and 1868 we need not despair of seeing the Leonids at their best until after 1901 is past.

THE METEORS OF BIELA'S COMET.

There was a very distinct, though not very brilliant, return of this shower on the nights of November 23 and 24. Little was seen of it in England, however, owing to cloudy skies. Mr. C. E. Willis, of Norwich, reports in "Nature" of December 7, 1899, that on November 24, between 10^h and $11^h\ 25^m$, he saw 52 Andromedids and 10 other meteors.

Prof. Young, of the Princeton Observatory, saw 42 meteors of this shower on November 23, and secured several photographs. The shower was also seen at Charkow, Delhi, Lemberg, Vienna, Pola, Munchen, Boston Mass., Northfield Minn., and other places. At Vienna, on November 23, 6^h to $9^h\ 40^m$, 65 meteors

were seen, while on November 24, 6^h to 10^h 30^m, 240 were counted. The maximum was at about 8^h (6^h 55^m G.M.T.). Mr. Gregg, at Malvern, watched for the shower on November 23, and saw three of its meteors between 9^h and 9^h 30^m, when the sky unfortunately became cloudy.

DECEMBER GEMINIDS.

A gibbous moon and the prevalence of a very severe frost and snowstorms prevented the successful observation of these meteors. Mr. King reports that he looked out as follows:—

December 1, 10^h to 11^h, six meteors, no Geminids.
8, 9^h 35^m to 11^h 10^m, nine meteors, two Geminids.
13, 17^h 10^m to 18^h 30^m, five meteors, no Geminids.

Mr. T. W. Backhouse watched for short periods on the nights from November 25 to December 14, but very few meteors were seen. Mr. T. H. Astbury says that there was a considerable number of Geminids observed on December 8 and 9, the chief centre of radiation being at about $110° + 25°$, and much further S. than he had expected to find it. Mr. Gregg watched the sky on December 10, 12^h 10^m to 13^h 30^m, and counted 17 meteors, of which 15 were Geminids. They were all about 4th magnitude, with short paths, and several of them appeared to be almost stationary.

The Fireballs of 1899.

A considerable number of these beautiful objects were observed in England during the year. The real paths of those which were recorded with sufficient fullness and precision have been computed, and the details are included in the table. But the majority of the large meteors have escaped adequate notice at the hands of observers, and are therefore quite lost to us, for no particulars can be preserved except the bare date and hour of their apparitions. Regular meteoric observers often miss fireballs which are apt to come into view at odd times, and often when least expected, as, for example, the large daylight meteor of January 9, 1900, 2^h 55^m p.m. In many cases we must necessarily depend upon outside help for the materials wherewith to investigate the paths of these bodies though the descriptions of persons possessing little astronomical knowledge or training is seldom of much utility. The assistance of astronomical observers generally would be very valuable in this field. Whenever a fireball is seen its apparent course amongst the stars, and estimated duration of flight, should be carefully recorded. In reporting the observation the R.A. and Dec. of the beginning and end points of the course should be given, as these figures can be more expeditiously dealt with than in cases where star names are mentioned. Mistakes are frequently made in the Greek letters, the computer sometimes has a difficulty in identifying a small star named, and sometimes becomes doubtful as to the meaning of the observer.

The radiant points derived from multiple observations of really well-observed fireballs and shooting stars afford important evidence upon some interesting points of meteoric astronomy. Observers will, therefore, perform a useful service to this branch in recording such bodies, whenever they are seen, as fully and correctly as possible.

Fireballs have often been remarked as numerous at the opening of March, and in 1899, March 1, two very fine Geminids were seen by Mr. Astbury and several other observers.

On April 4 there was a brilliant Librid, but it was not well seen, and the path derived is somewhat doubtful. June 2 brought us a Venus-like Scorpiid, but it could not be accurately followed in the strong twilight. This radiant in Scorpio has often attracted attention from the very large meteors it yields near the time of midsummer. Its activity is not, however, confined to June, for bright meteors are directed from the same centre from early in May to the closing days of September.

About 10 very brilliant meteors were observed by those who watched the return of the August display. They were Perseids, as bright as, or brighter than, Venus, which lit up the sky with strong flashes, and left vivid green streaks, enduring for intervals from 30 seconds to 3½ minutes.

But the best observed fireball of the year was that which appeared in the early evening of August 24. It was a fine Pegasid, and the Director collected 49 accounts of it. It moved nearly E. to W., at normal heights, over the North Sea. Another fireball was seen at a later hour on the same night, and this, with a similar object widely observed in England on August 27, came from a radiant at 191° + 32°.

Unusually large meteors were also recorded on September 2, 8, and October 2, which admitted of satisfactory discussion.

A fireball appeared during the Leonid watch on November 14, at $17^h\ 40^m$, and left a streak for five minutes. It was seen by many observers, though but one or two troubled to record its apparent course. Fortunately the excellent places furnished by Sir W. J. Herschel, at Littlemore, near Oxford, enabled the real path to be determined, and the meteor proved to be from a similar radiant in Canes Venatici (S. of Cor. Caroli) to that which supplied the fireballs of August 24 and 27.

Several brilliant Leonids were interspersed among the comparatively few meteors which the celebrated mid-November stream furnished this year. On November 15, at about $16^h\ 50^m$, two Venus-like Leonids appeared almost simultaneously, and were noticed at many places.

In concluding this part of the subject we may mention the great Russian meteor of March 12, 1899. It fell to the earth near Burbely, a village 14 miles from Borgo. The pieces were collected, and weighed 850 lbs., the largest fragment being 206 Russian lbs. The meteor appeared between 9 and 10 p.m., and those who witnessed its descent say the sky was suddenly lit up with a bluish-white glare like the electric light. "The nucleus was a "flaming mass, of irregular form, surrounded by a nebulous veil, "and with a train depositing small red stars." Prof. Herschel has compared a number of descriptions and finds that the radiant point was in about 105°—20°. The direction of motion was from a little E. of S., and the aerolite in its flight of about 200 miles passed nearly over Dorput and Wisenberg, and thence over the Gulf of Finland to its earth point near Borgö. The "Daily Graphic" of April 17, 1899, gave a sketch of the cavity caused by the fall of the meteor, which is stated to have been some 12 feet in diameter and 27 feet deep.

Radiant Points of Meteoric Showers, 1899.

B.A.A. Ref. No.	Date.	Name.	Radiant Point. α ° δ °	No. of Meteors.	Class.	Observer.
	1899.					
853	Jan. 4 - -	α Leonids -	154½ + 12	4	VR	W. E. B.
854	May 3–5 -	α Canum Ven.	194 + 46	5	S	E. R. B.
855	„ 3–7 -	π Herculids -	255 + 37½	7	ST	E. R. B.
856	„ 3–7 - -	ε Bootids -	218 + 24	6	R	E. R. B.
857	„ 3–7 -	γ Draconids -	267 + 50	5	R	E. R. B.
858	„ 3–7 - -	γ Delphinids -	308 + 16	5	RK	E. R. B.
859	„ 4–5 -	α Coronids -	232 + 23½	6	SB	E. R. B.
860	„ 4–7 - -	ζ Bootids -	216½ + 18	9	S	E. R. B
861	„ 3–9,	ξ Ursids - -	173 + 29	6	S	A. S. H.
	1894–99.					
862	May 3–9 -	α Virginids -	204 − 3	7	SB	A. S. H.
863	„ „ - -	θ Bootids -	208 + 52	7	—	A. S. H.
864	„ „ -	ζ Librids -	230 − 20	4	M	A. S. H.
865	„ „ - -	θ Coronids -	232 + 32	7	—	A. S. H.
866	„ „ -	β Triangulids	24 + 32	5	RK	A. S. H.
867	„ „ - -	θ Draconids -	245 + 55	6	—	A. S. H.
868	„ „ -	α Scorpiids -	252 − 24	4	—	A. S. H.
869	„ „ - -	ψ Draconids -	274 + 75	8	SB	A. S. H.
870	„ „ -	ε Sagittids -	288 + 12	6	VR	A. S. H.
871	„ „ - -	α Capricornids	304 − 12	5	—	A. S. H.
872	„ „ -	β Aquarids -	315 − 14	5	VRK	A. S. H.
873	„ „ - -	Vulpeculids -	318 + 24	5	—	A. S. H.
874	„ „ -	μ Cygnids -	325 + 30	5	R	A. S. H.
875	„ „ - -	γ Aquarids -	335 − 1	4	VRK	A. S. H.
876	June 29–July 8 -	η Pegasids -	333½ + 27	6	R	A. S. H.
877	„ „ -	λ Aquilids -	283 − 14	6	S	A. S. H.
878	July 4–16 -	ω Draconids -	273 + 68	5	R	W. F. D.
879	July 28–Aug. 14	ζ Cassiopeids -	2 + 48	13	—	A. K.
880	„ „	β Cassiopeids -	359 + 59	5	M	A. K.
881	July 30–Aug. 14	γ Andromedids	21 + 40	5	R	A. K.
882	„ 30– „ 11	β Andromedids	16 + 31	4	RK	W. F. D.
883	„ 30– „ 13	δ Aquarids -	339 − 11	8	S	W. F. D.
884	„ 31– „ 12	ε Pegasids -	325 + 9½	6	R	A. K.
885	„ 31– „ 14	α Ursæ Min. -	{ 0 + 90 / 85 + 87 }	7	R	A. K.
886	„ 31– „ 13	δ Cassiopeids -	{ 18 + 59 / 25 + 62½ }	10	K	A K.
887	„ 31– „ 16	β Piscids -	345 ± 0	9	M	W. F. D.
888	Aug. 1–12 -	δ Cassiopeids -	17½ + 58	5	—	J. H. B.

B.A.A. Ref. No.	Date.	Name.	Radiant Point. α ° δ °	No. of Meteors.	Class.	Observer.
	1899.					
889	Aug. 1–11	β Cepheids	326 + 70	6	—	J. H. B.
890	„ 1–Oct. 2	β Piscids	345 + 1	6	S	A. K.
891	Aug.-Sept.	ι Andromedids	346 + 36	10	R	A. K.
892	„ „	φ Pegasids	356 + 20	6	R	A. K.
893	Aug. 6–16	κ Cepheids	315 + 77	10	M	W. F. D
894	„ 8–14	φ Andromedids	26 + 48½	12	RK	A. K.
895	„ 9–14	χ Perseids	32½ + 56	10	—	J. H. B.
896	„ 9–16	o Draconids	293 + 60	8	S	W. F. D.
897	„ 9–17	η Pegasids	332 + 27	8	M	W. F. D.
898	„ 9–14	Camelids	61 + 58	10	VRK	A. K.
899	„ 10–18	ω Draconids	277 + 70	15	S	W. F. D.
900	„ 10	ε Perseids	64 + 34	7	—	W. E. B.
901	„ 10–14	ζ Cassiopeids	4 + 51½	19	—	W. E. B.
902	„ 10–14	λ Aquarids	340 − 5	5	—	W. E. B.
903	„ 11–13	λ Andromedids	354 + 50	5	RK	A. K.
904	„ 11–16	ε Arietids	40 + 21	5	RK	W. F. D.
905	„ 13–17	α–β Perseids	47 + 44	6	RK	W. F. D.
906	„ 14–18	Vulpeculids	323 + 23	5	R	W. F. D.
907	Sept. 27–Oct. 8	β Perseids	40 + 38½	10	RK	A. K.
908	„ 27–Nov. 6	α Cetids	39 + 4	4	—	A. K.
909	Oct. 30– „ 1	β Andromedids	13 + 30	4	Short	A. K.
910	„ 30– „ 6	ζ Arietids	50 + 20½	4	SB	A. K.
911	„ 30– „ 6	β Perseids	41 + 40	6	RK	A. K.
912	Nov. 6–10	ρ Taurids	52 + 8	40	M	A. S. H.
913	„ „	o Orionids	68 + 17	7	S	A. S. H.
914	„ „	Monocerotids	121 − 1	5	R	A. S. H.
915	„ „	σ Ursids	134 + 67	5	R	A. S. H.
916	„ 6–13	κ Leonids	143 + 29	6	RK	A. S. H.
917	„ 8–13	Arietids	48 + 26	6	R	J. H. B.
918	„ „	ρ Leonids	160 + 11	4	RK	A. K.
919	„ 8–15	ι–κ Ursids	132 + 46	4	VR	A. K.
920	„ '98 and '99	δ Cancrids	130 + 20	4	Long paths.	A. K.
921	„ 12–16	Leonids	150 + 23	5	RK	A. S. H.
922	„ 14	„	154 + 25	—	RK	I. F. H. C. Gregg.
923	„ 15	„	151½ + 22	7	VR	A. K.
924	„ 23–Dec. 1, 1899, &c.	κ Draconids	186 + 73	5	RK	W. F. D.
925	Dec. 8–9	δ Geminids	110 + 25	17	—	T. H. A.

Radiants of August Perseids were summarised in "Journal," Vol. IX., p. 430.

REAL PATHS OF FIREBALLS AND SHOOTING STARS OBSERVED AT TWO OR MORE STATIONS IN 1899.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1899.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
Mar. 1	7 0	4× ♀	73	28	53	21	Wolverhampton -	Shrewsbury -	119 + 31	β *Geminid*	T. H. A.; Sir W. J. H.; Rev. A. T. Fryer.
„ 1	8 49	4—♀	58	22	39	10	Romford - -	Harlow, Essex -	119 + 33	β *Geminid*	T. H. A.; G. T. Davis; C. Parker.
April 4	7 59	2× ♀	60	52	160	—	10 W. Whitehaven -	N. coast, Ireland -	202 − 10	α *Virginid*	R. Killip; C. Parker; Parry
June 1	9 20	4+4	90	30	—	—	King's Lynn -	King's Lynn -	209 + 51	θ *Boötid*	3 observers.
„ 2	8 47	♀	61	51	170	Slow	Totnes -	S. George's Channel	250 − 23	α *Scorpid*	T. Harries; H. C., and others.
„ 29	10 33	3—1	66	42	49	—	14 miles E. Foulness Point.	Brentwood - -	330 + 26	η *Pegasid*	T. H. A.; J. H. B.
July 4	10 50	2	54	46	27	13	Halcombe, Sussex -	Richmond, Surrey -	281 − 16	*Aquilid*	T. H. A.; J. H. B., and W. F. D.
„ 8	10 42½	4	53	41	14	18	Windsor - -	Thame, Oxon -	316 + 48	α *Cygnid*	A. S. H.; J. H. B.
„ 8	10 55	3—1	46	42	14	10	Banbury, Oxon -	10 miles W. Northampton.	253 − 20	α *Scorpiid*	A. S. H.; J. H. B., and W. F. D.
„ 8	10 57	4—2	36	33	3	—	Quainton - -	Quainton - -	294 + 61	o *Draconid*	A. S. H.; T. H. A.
„ 13	10 55	3	75	69	15	21	Harlow - -	Clavering - -	283 − 13	λ *Aquilid*	T. H. A.; J. H. B.
„ 16	11 10	4	78	65	14	18	6 miles S.S.E. Oxford.	7 miles E. Oxford -	263 + 36	ρ *Herculid*	A. S. H.; W. F. D.
„ 29	11 9	4	55	54	12	13	Wantage - -	Buckland, Berks -	317 − 31	ζ *Capricornid.*	A. S. H.; W. F. D.
„ 29	11 13	2<1	62	47	17	27	Towcester - -	Daventry - -	323 + 34	ζ *Cygnid*	A. S. H.; W. F. D.
„ 29	11 51	4	68	57	25	33	——	——	3 + 10	γ *Pegasid*	A. S. H.; W. F. D.
Aug. 1	11 10½	3—2	68	50	59	—	Dunstable -	Nuneaton - -	335 − 11	α *Aquarid*	J. H. B.; W. F. D.
„ 6	10 36	2½—2	78	60	33	33	Wolverton - -	Oxford - -	39 + 57	*Perseid*	T. H. A.; W. F. D.
„ 9	10 19	3—2	88	61	51	—	7 miles N. Leicester	Stratford-on-Avon -	40 + 57	*Perseid*	T. H. A.; T. E. R. P.; W. F. D.

	„ 10	10 14	♃—♀	76	40	54	—	Cheltenham -	Bridgwater -	41 + 57	*Perseid*	T. H. A.; T. E. R. P.; S. J. J.; W. F. D.
	„ 10	10 54	♃	97	51	79	—	Mildenhall, Suffolk	Chesham, Bucks -	45 + 58	*Perseid*	
	„ 11	11 3½	1	75	53	38	38	Ilmington, Worcester.	Stroud - -	46 + 57	*Perseid*	A. S. H.; W. F. D.
	„ 14	9 31	3—1	67	61	19	—	7 miles S.E. March, Camb.	10 miles N.N.W. Cambridge.	52 + 46	*α Perseid*	J. H. B.; I. F. H. C. Gregg.
	„ 24	8 11	☽	77	27	118	17	N. Sea - -	N. Sea - -	345 + 14	*α Pegasid*	49 observers.
	„ 27	10 13	<♀	68	47	143	25	Wigan - -	Cambridge - -	191 + 32	*β Coma Ber.*	6 observers.
	Sept. 2	12 4½	3×♀	86	60	28	—	Shipston, Warwick-	Tewkesbury -	46 + 42	*α-β Perseid*	I. F. H. C. Gregg; W. F. D.
	„ 4	8 13½	♃—♀	67	21	52	34	Farnham - -	Havant, Hants -	311 + 79	*κ Cepheid*	A. S. W.; T. H. A.
	„ 8	8 21	>♀	71	26	114	20	English Channel -	Alresford, Hants -	347 + 3	*β Piscid*	T. H. A.; A. King.
	Oct. 2	8 24	♀	67	45	88	13	12 miles N.W. Ilfracombe.	Newbridge, Radnor	284 − 17	*λ Aquilid*	J. P. H. Boileau; W. S. Price.
	„ 5	10 55½	2	52	45	14	20	Leighton Buzzard -	Wendover - -	137 + 65	*σ Ursid*	A. S. H.; T. H. A.
	„ 10	11 6	3—1	48	43	13	21	Kingston, Surrey -	Brentford, Middlesex	35 − 10	*ρ Cetid*	A. S. H.; J. H. B.
	„ 16	8 37½	2—1	73	48	27	—	Wiley, Salisbury Plain.	12 miles S.W. Salisbury Town.	334 + 74	*β Cepheid*	T. H. A.; S. J. J.
	Nov. 10	13 16	4—2	58	46	18	18	5 miles S.E. Cheltenham.	10 miles N.E. Cheltenham.	55 + 5	*e Taurid*	A. S. H.; W. F. D.
	„ 10	13 37½	4	90	48	46	32	Godalming - -	Chobham - -	72 + 32	*ι Aurigid*	A. S. H.; W. F. D.
	„ 13	15 13½	3—2½	65	55	40	57	22 miles S. of Newhaven.	12 miles N.N.W. Brighton.	130 − 20	*Monocerotid.*	A. S. H.; J. H. B.
	„ 14	17 40	♃—♀	71	42	46	—	Buckingham -	Shipston - -	193 + 27	*β Coma Ber.*	Sir W. J. H.; T. E. R. P.; W. C. Tetley, and others.
	„ 15	16 48	>♀	83	50	43	—	St. Anne's-on-Sea -	12 miles S.W. Ravenglass, Lancashire.	150 + 20	*Leonid*	R. Killip; A. L. Cortie.
	„ 15	16 50	♀	82	45	49	—	Wigan - -	Blackpool - -	151 + 21	*Leonid*	A. C. Allen; R. Service; D. A. Lampleigh.
	„ 19	8 5½	♃	85	42	68	23	40 miles E. Hornsea, Yorks, coast.	Driffield - -	60 + 28	*ψ Taurid*	T. W. Backhouse; C. L. Brook.

Mean height at beginning 69 miles, at ending 46 miles. Length of path 50 miles.

REAL PATHS OF BRIGHT PERSEIDS. *Computed by* Lieut.-Col. G. L. TUPMAN, R.M.A.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Path.	Velocity per second.	Radiant Point.	Observers.
1899.	h m		Miles.	Miles.	Miles.	Miles.	α° δ°	
Aug. 9	10 32	1—♀	83	61	40	40	*48+57	J. H. B.; J. E. Clark.
„ 9	11 4½	>1—2	62	46	28	32	40+53	J. H. B.; W. F. D.
„ 10	11 2	1	76	60	24	34	45+57	T. H. A.; T. E. R. P.; W. F. D.
„ 10	11 31	1	63	50	23	25	45+57	T. E. R. P.; W. F. D.
10	11 35	>1—2	60	41	37	36	45+55	J. H. B.; W. F. D.
„ 11	11 10	2	77	53	39	44	*46+58	T. E. R. P.; S. J. J.; W. F. D.
Means	—	—	70	52	32	37		

* In these cases the exact places of the radiants are doubtful.

The abbreviations in this and preceding tables are :—

T. H. A. = T. H. ASTBURY, Wallingford.
E. R. B. = E. R. BLAKELEY, Dewsbury.
W. E. B. = W. E. BESLEY, London.
J. H. B. = J. H. BRIDGER, Farnborough.
H. C. = H. CORDER, Bridgwater.
W. F. D. = W. F. DENNING, Bristol.
S. J. J. = Rev. S. J. JOHNSON, Bridport.
A. S. H. = Prof. A. S. HERSCHEL, Slough.
A. K. = A. KING, Leicester.
T. E. R. P. = Rev. T. E. R. PHILLIPS, Yeovil.

BRIGHT METEORS OBSERVED DURING 1899.

Date.	Time.	Mag.	Remarks.
1899.	h m s		
Jan. 26	8 56 0	♀	From 178½° + 60° to 171½° + 54°. Colour bluish white streak 3° or 4°.—A. KING, Leicester.
„ 26	8 56 0	VB	From centrally between the two stars in the Bear's tail, towards ε Draco. After the meteor had burst the remains of it were visible in the bright moonlight like a great cloud for 4 or 5 secs. Path very short.—H. SHEPPARD, Bishop's Stortford.
Feb. 8	6 9 0	Vega	From W. of zenith towards Vega. The meteor came into view nearly half way between the zenith and Vega.—J. T. BIRD, Dublin.
„ 12	8 45 0	VB	Fell vertically in azimuth 70° W. of S., alt. 35° to 15°. Duration 2 secs.—Thos. HARRIES, Llanelly.
Mar. 1	7 1 0	Sirius	From 340° + 63° to 323° + 44°. Bluish white. Duration 2½ secs. No streak. Appeared to be in flames.—T. H. ASTBURY, Wallingford.
„ 1	7 0 0	4 + ♀	From a point 5° p., β Cassiopeiæ, nearly vertically to horizon (reached within 10° of horizon). Duration 2½ secs. Bluish at the bright end. Trail died out before head.—Sir W. J. HERSCHEL, Littlemore, near Oxford.

Date.	Time.	Mag.	Remarks.
1899.	h m s		
Mar. 1 -	6 50 0	VB	Descended in a line apparently parallel to the lower part of Ursa Major, as then in the heavens. Path curved. Meteor very light blue in body but ending in brilliant red of a deep tone like the red which a winter sun shows in setting. The nucleus was peculiar, almost fish-shape.—Rev. A. T. FRYER, Bridge d.
„ 1 -	8 45 0	♀	From 187½° + 40½° to 205° + 35°. Duration 1½ sec. No sparks or train.—G. T. DAVIS, Reading.
„ 1 -	8 51 0	4	From 168° + 33° to 191° + 25°. Yellowish. Duration 4 secs. Dilated thrice towards end.—T. H. ASTBURY, Wallingford.
„ 1 -	8 50 0	>♀	From about α Leonis to δ Crateris. Whitish trail.—C. PARKER, Handsworth, Birmingham.
„ 1 -	10 27 0	1	From 112¾° + 25° to 108¾° + 8°. Greenish. Duration 1 sec.—A. King, Leicester.
„ 5 -	18 7 0	2 × 4	Below 4 moving S.E. towards Saturn. 4 secs.—F. H. WRIGHT, North Hants.
„ 6 -	17 45 0	Fireball	Great detonating meteor passed over Nashville, Tenn. It travelled a little W. of N., leaving a brilliant trail of blue light and sparks in its path. About 2 mins. afterwards three distinct explosions were heard, the first louder than the rest. This was followed immediately by a rumbling noise and a shaking as if of an earthquake. The shock was not violent enough to cause any damage but it made windows and doors rattle.—Newspaper cutting from E E. BARNARD, who was in Nashville at the time.
„ 9 -	7 6 0	>♀	From N.W. alt. 35° to S., falling vertically, disappearing close to horizon. Rapid. Blue colour. Head pear-shaped.—C. F. SMITH, Edinburgh.
„ 14 -	9 57 0	4	At π Leonis. Course ¼° downwards.—Rev. S. J. JOHNSON, Bridport.
„ 23 -	9 30 0	Fireball	Emanated from Leo, and disappeared midway between the moon and horizon. When it had travelled about three-fourths of its course it divided into three parts, from behind, and appeared like three meteors, the second and third being the size of a tennis ball and an egg respectively, and of the brightness of stars of the 1st and 2nd mag., while the original seemed about the size of a child's football, and grew in brilliancy until it expired.—J. BROWN, Wincanton, Somerset.
„ 23 -	9 30 0	VB	At Tiverton, Devon, two stars shot across the sky from E. to W., one was apparently much larger than the other, the larger taking precedence.
„ 31 -	11 12 0	VB	Head 1½° by 15′. Died out about 30° above the N.E. horizon. Directed from S.W. by S. Duration about 10 secs.—G. T. DAVIS, Reading.
Apr. 4 -	7 56½ 0	2 × ♀	From α Cassiopeiæ, crossed φ Andromedæ, and disappeared 8–10° above W.N.W. horizon. Bluish streak. Pear-shaped nucleus. Caused a very sudden and brilliant illumination of the firmament.—Rev. R. KILLIP, St. Anne's-on-Sea.
„ 4 -	7 59 0	>4	From η Ursæ Majoris to β Cassiopeiæ, and 1° beyond the latter star.—C. PARKER, Handsworth, Birmingham.
„ 4 -	11 51 0	Sirius	From 215° + 64° to 188° + 41°. Moved slowly.—A. S. HERSCHEL, Slough.
„ 4 -	8 0 0	2 × ♀	From a little below α Cassiopeiæ to β Andromedæ. Broke into pieces.—R. PARRY, Hoole, Chester.

Date.	Time.	Mag.	Remarks.
1899.	h m s		
Apr. 5 -	10 12 0	Sirius	Directed from about ι Hydræ, disappeared at 103°-6°. Course, 4°.—T. W. BACKHOUSE, Sunderland.
„ 8 -	10 5 0 (Local Time)	VB	Fireball observed at Delhi, starting from the N. and falling to the S. horizon. It left a red trail. The phenomenon was one of dazzling brilliancy. About a dozen smaller meteors were seen about 15 minutes before and after the fireball.
„ 15 -	9 51 0	<♃	Started at o Ursæ Majoris, took a curiously curved path to the E., and vanished 10° E. of Capella. Duration, 3½ secs.—Rev. S. J. JOHNSON, Bridport.
„ 19 -	12 2 0	2½×♃	Magnificent meteor moving from about 209° + 5° to 190°—26°. Pale green colour. Observer missed the beginning, but his attention was attracted by the startling flash of light in the S. There was thin cirro stratus cloud over the sky and bright moonlight.—Rev. T. E. R. PHILLIPS, Yeovil.
„ 27 -	8 20 0 (Local Time)	3 × ♃	Fell about 23° E. of the moon, and was slightly inclined W. Disappeared behind trees when close to horizon.—E. G. ROBERTS, Masulipatam, India.
May 6 -	11 13 0	♃	From 192½° + 40° to 181½° + 31°. Swift. Duration, ½ sec.—A. KING, Leicester.
„ 27 -	8 53 0	3 × ♃	From 246° + 26° to 252° + 16°. ¾ secs. Died out suddenly without explosion.—T. H. ASTBURY, Wallingford.
„ 28 -	10 38 0	♃	Fell under the Polar star, in the direction of Cassiopeiæ. Visible 5 to 7 secs. Left a bright trail of light.—Miss AGNES FRY, Failand, near Bristol.
„ 28 -	10 30 0	♃	Passed κ Herculis, and directed downwards half way between β and ζ Herculis.—H. CORDER, Bridgwater.
une 1 -	9 20 0	VB	From near β Draconis, and fell in a vertical line to within 15° of the horizon. Colour bluish white, inclining to orange. Visible flight lasted 3 secs., and the luminous streak it left soon broke up and disappeared.—P. K., Kettering.
„ 1 -	9 18 0	4 × ♃	From slightly E. of S.E., fell straight down from a great altitude. Colour pale gold, short tail. Duration, 2 secs. Obs. at Dewsbury.
„ 1 -	9 20 0	VB	Fine meteor, burst like a rocket near Cassiopeiæ. Short train.—W. LUCKING, Bishop's Stortford.
„ 2 -	8 45 0	♀	From Lec, towards due W. to 30° above horizon. Colour pure white. Duration, 4 secs. Its path was curvilinear, resembling that of a projectile when thrown up at a small angle.—T. HARRIES, Llanelly.
„ 2 -	8 40 0	VB	Small globe of light like a clear electric ball, travelled quite slowly from E. to W., descending gradually until it seemed to go out. Visible 2 or 3 secs. Not very high in the heavens.—Miss JESSIE M. EVANS, Weston-super-Mare.
„ 2 -	8 55 0	4 × ♃	Probable course from about β Leonis, perhaps higher, down to N.W. horizon just over position of sun. Two Observers at Bridgwater.
„ 5 -	10 12 0	Sirius	From 258° + 23° to 262° + 12°. Colour red, changing to blue. Brilliant white flash at end as bright as Jupiter. Duration, 1¼ sec.—T. H. ASTBURY, Wallingford.
„ 5 -	10 11 0	♃	Path from Draco into Corona.—R. CROSS, Oxford.
„ 8 -	12 28 0	♀	From 87° + 69° to 118° + 59°. Green. Faint train.—A. KING, Leicester.
„ 10 -	13 53	Sirius	At 280°—14°. Seen through a tree.—T. W. BACKHOUSE, Torquay.

Date.	Time.	Mag.	Remarks.
1869.	h m s		
June 10 -	9 11 0	5 × 4	Moved from S. to S. by W., and alt. about 55° to 30°. Swift, rather short course. Burst into two, the first part shooting ahead and becoming red before extinction. Colour bluish white.—A. L. CORTIE, S.J., Stonyhurst.
July 12 -	9 40 0 (Local Time)	>♀	Started just under α Cygni, traversed N. side of Milky Way, and vanished just under ξ Cassiopeiæ. Very slow motion, The head was divided into three portions.—Rev. T. H. FOULKES, Kandia, Crete.
„ 29 -	9 20 0	2 × ♀	Falling from 5° below ε Cassiopeiæ to 5° above Capella. —W. J. STANTON, Stroud, Gloucestershire.
„ 29 -	10 54 0	Sirius	From 43° + 37° to 60° + 47°. Rather swift. 1½ secs. —A. S. HERSCHEL, Slough.
„ 30 -	12 42 0	4	From 245° + 30° to 215° + 32°. Slow. Aquarid.— W. F. D., Bristol.
„ 31 -	10 53 0	>4	From 118° + 71½° to 118° + 68°, Got brighter to end and then burst, when it was nearly = ♀. Duration, 0·7 sec.—A. KING, Leicester.
„ 31 -	11 3 0	>4	From 336¾° + 16¾° to 341¼° + 31¼°. Train. Aquarid. 1½ secs.—A. KING, Leicester.
„ 31 -	11 5 0	ν B	Large fireball moving S.E. to N.E. Finishing under square of Pegasus.—C. PARKER, Handsworth, Birmingham.
Aug. 4 -	9 46 0	5 × ♀	From 241¾° + 23° to 218¾° + 25°, when it burst, and finally disappeared in 208° + 22½°. [Probably a fine Aquarid.]—E. M. ANTONIADI, Juvisy.
„ 4 -	12 57 0	>♀	From 70° + 38° to 76° + 30°. Duration, 1 sec.—G. T. DAVIS, Reading.
„ 18 -	8 9 0	4	Course from about 15° E. of Arcturus to a point 10° above Jupiter. Rev. S. J. JOHNSON, Bridport.
„ 24 -	8 11 0	⅛ = ☽	From 352° + 13½° to 2° + 12½°. Duration, 3 secs. Yellowish white, leaving sparks of a red hue. Twilight and rising moon obscured some of the stars, but it was just possible to make out γ Pegasi, below which the fireball appeared. — C. L. BROOK, Meltham, Huddersfield.
„ 24 -	8 11 0	♀	Dropped out of Perseus in N.E., and moved towards Capella, but not so far as that star. Motion slow. Duration, 5 or 6 secs.—E. W. JOHNSON, South Croydon.
„ 24 -	8 13 0	2 × ♀	From β Andromedæ to horizon below Capella. Reddish, leaving trail, then burst into bluish white.— S. H. R. SALMON, South Coydon.
„ 27 -	10 11 0	⅛ = ☽	From N.W. to S.E. Deneb Cygni to Aquarius, where it suddenly disappeared. Bright yellow. Duration, 4 secs. A magnificent pear-shaped fireball.—J. L. WHITTLE, Manchester.
„ 27 -	10 15 0	VB	From Ursa Majoris, through Auriga and Perseus. Duration, 4 secs. Lieu.-Col. J. P. H. BOILEAU, M.D., Trowbridge.
„ 27 -	10 15 0	VB	From N.W. to S.E. Moved slowly. Two Observers at Birmingham.
„ 27 -	9 15 0	♀	From 216° + 38½° to 201½° + 32½°. Slow.—W BESLEY, London, S. W.
„ 28 -	9 30 0	4	From 302¾° + 13½° to 315¼° − 5. Slow. Train. 1 sec. —W. E. BESLEY, London, S.W.
„ 28 -	12 35 0	= ☽	From 292½° + 17° to 301° + 3°. Slow. Train. ½ sec.— W. E. BESLEY, London, S.W.

Date.	Time.	Mag.	Remarks.
1899.	h m s		
Sept. 2 -	12 4½ 0	3 × ♀	From 40° + 67° to 37° + 74°. Rather swift. Lit up the sky, and left a streak for 1 minute.—W. F. D., Bristol.
„ 2 -	12 5 0	>♀	From 15° + 45° to 345° + 40°. Magnificent meteor. Very swift, trail visible for 1 min. in middle of path. Colour bluish white.—IVOR F. H. CARE GREGG, Great Malvern.
„ 4 -	8 9 0	α Lyræ	From 265° + 52° to 271° + 19°. 1½ sec. Bluish white, with red sparks.—A. S. HERSCHEL, Slough.
„ 4 -	8 13 0	♀	From 220° + 35° to 217° + 35°. 2 secs. Rather slow.—A. S. WILLIAMS, Hove.
„ 4 -	8 14 0	♃	From 297° + 28° to 296° + 13°. Yellow, bright streak. T. H. ASTBURY Wallingford.
„ 8 -	8 24 0	>♃	From S.E. to S.W. Bluish green. Splendid meteor.—C. PARKER, Handsworth.
„ 8 -	8 21 0	>♀	From 313° + 4° to 287° + 4°. 2¾ secs. Bluish white. Slight train. Flashed out brilliantly 4° from end point.—T. H. ASTBURY, Wallingford.
„ 8 -	8 24 0	VB	Passed under μ and ε Aquarii at a little greater distance than that between β-η Pegasi, directed from 1° above γ or θ Piscium. It ended in a kind of explosion about 1½ the apparent visual area of the moon, but it was much veiled by clonds.—A. KING, Leicester.
„ 9 -	11 37 0	>1	From 67½° + 20° to 70° + 15°. Slow. Deep orange colour, head pear-shaped.—IVOR F. H. C. GREGG, Great Malvern.
„ 15 -	12 24 0	VB	From region of Pegasus to a little below the moon. Sky much clouded, and precise course could not be assigned. Motion rapid.—D. R. FOTHERINGHAM, Leith.
„ 17 -	9 0 0	VB	From β and γ Draconis to α-β Cassiopeiæ.—Lieut.-Col. BOILEAU, Trowbridge.
„ 27 -	10 33 0	>1	From κ Tauri, passing E. of Pleiades to about 20° beyond them towards α Trianguli. Left a broad trail.—JESSIE MCRAE, South Croydon.
Oct. 2 -	8 20 0	VB	From Corona Borealis to Ursa Major, disappearing below ε on a line drawn from γ to η. Shortly before going out it divided into two distinct portions, one following the other on the same line. Left a short train. Duration 4 or 5 secs.—Lieut.-Col. BOILEAU, M.D., Trowbridge.
„ 2 -	8 24 0	♃	Passed just above Ursa Major from about 207° + 63° to 144° + 62°. Nucleus of a decidedly deep yellow colour, and left a slight trail of short duration. Towards end of path meteor divided into 4 distinct fragments, so ——●-●-●-●>. The meteor travelled with exceptional slowness even for an object moving from W. to E.—W. S. PRICE, Wellington.
„ 2 -	11 6 0	>1	From 105° + 37½° to 112½° + 42°. Slow. Streak.—J. H. BRIDGER, Farnborough.
„ 8 -	6 3 0	VB	Appeared in S.W., alt. 30°, passed overhead, and disappeared in N.E. at alt. 30°. Colour, glistening primrose yellow with a bright golden tail about 3° long. When overhead it threw off two small portions which trailed behind and disappeared. Duration 10 secs.—J. H. BATEMAN, West Norwood.
„ 8 -	6 0 0	VB	Course S.W. to N.E. and exactly overhead; very slow, 8 to 9 secs. passing over. Just after crossing zenith it emitted two sparks. Left a long train.—W. NASH, Epsom.

Date.	Time.	Mag.	Remarks.
1899.	h m s		
Oct. 8 -	6 0 0	VB	Travelled from S.W. to N.E. by E., and at a very slow speed. Visible 10 to 12 secs.—Correspondent of "Wellingboro' News."
„ 8 -	8 15 0	>1	From 47° + 51° to 119° + 74½°. Left a train, and occupied 2½ or 3 secs. in its flight.—A. KING, Leicester.
„ 8 -	11 40 0	VB	Small fireball. From 2° + 10½° to 32° + 10°. Very dull red colour. Perceptible disk. Streak. Duration 5 secs.—C. L. BROOK, Meltham, Huddersfield.
„ 10 -	10 17 0	♀	From 95½° + 63° to 222 + 85. Rapid. Streak. Orionid. —J. H. BRIDGER, Farnborough.
„ 11 -	11 16 0	4	From 325° + 60° to 299° + 39°. Streak. Orionid.—A. S. HERSCHEL, Slough.
„ 16 -	10 1 0	2 × ♀	From 93° + 34° to 93½° + 57°. Rather slow, about 2 secs. It left a perfectly straight streak lasting about 1 sec. Colour=4. Orionid.—C. D. P. DAVIES, Chichester.
„ 25 -	10 8 0	>♀	From 127° + 77° to 180° + 86°. Moderate speed. Colour bluish white. Dense streak enduring 3 mins. and fading to an irregular oval shape.—J. H. BRIDGER, Farnborough.
„ 5 -	15 19 0 (Local Time)	4	From midway between ζ Orionis and Sirius to near η Leonis. Slow, yellow, and trained.—Capt. P. B. MOLESWORTH, Trincomali, Ceylon.
Nov. 10 -	13 8 0	Sirius	From 31° − 9° to 25½° − 14°. Slow.—A. S. HERSCHEL, Slough.
„ 13 -	13 8½ 0	Sirius	From 337° + 40½° to 330° + 35°. Swift. Streak.—A. S. HERSCHEL, Slough.
„ 12 -	9 50 0	VB	Fireball passed below the moon from N.E. to S.W. Very brilliant and pear-shaped. Greenish colour, and distinct trail. Speed moderate.—E. W. JOHNSON, South Croydon.
12 -	13 36 0	>1	From 134° + 82° to 72½° + 57. Rapid. Streak.—J. H. BRIDGER, Farnborough.
„ 14 -	17 40 0	4	From 163° + 63° to 70° + 66°. Orange yellow. 2½ sec. Streak. Visible 5 minutes.—Sir W. J. HERSCHEL, Littlemore, Oxford.
„ 19 -	8 5 0	4	From 73° + 35° to 86° + 42°. Small fireball. Yellowish white. Slow. 3 secs.—C. L. BROOK, Meltham, Huddersfield.
„ 19 -	8 6 0	4	Directed from about Capella, disappeared at about 25° − 4°. Course 18°. Very slow. Duration 2 secs. Train about 8° long, more or less red. Head yellowish white.—T. W. BACKHOUSE, Sunderland.
„ 26 -	6 0½ 0	4	From a point 1° above θ Cygni to a point 1° above 41 Cygni. (About 290° + 50° to 303° + 27).—Rev. J. JOHNSON, Bridport.
„ 26 -	10 32½ 0	♀	About 3° below τ^2 Eridani (54° − 27° to 53° − 31°). Greenish. At a low altitude.—Rev. S. J. JOHNSON, Bridport.
„ 27 -	9 20 0 (Local Time)	VB	From square of Pegasus to α Auriga. Just before this point the meteor divided into two, one going nearly into Cancer the other towards the Lynx.—C. N. NEUOFF, Sofia.
Dec. 1 -	11 25 0	>1	Path followed a line drawn from α Andromedæ through ν Cygni, originating a little distance beyond the latter star and towards the N. Path about 8° or 10° towards N. horizon. Deep orange colour.—W. S. PRICE, Wellington.

Date.	Time.	Mag.	Remarks.
1893.	h m s		
Dec. 10 -	18 0 0	VB	Just before this time a brilliant meteor with long train was seen here passing from E. to N.W.—Miss J. E. A. BROWN, Cirencester.
,, 10 -	17 45 0	VB	Large ball of fire fell in S.E. Compared to its brilliancy "the electric light was nowhere." It appeared in about alt. 45°, and burst after a vertical descent. Description given to Mr. H. W. SMITHIES by a Chelmsford carpenter.

The abbreviation "VB" in 3rd column signifies Very Bright.

SECTION FOR THE OBSERVATION

OF THE

COLOUR OF STARS.

DIRECTOR.—G. F. CHAMBERS, F.R.A.S.

A CATALOGUE OF RED STARS FOR 1900.

On an ordinary naked-eye view, the vast majority of the stars may be said to shine as silvery white points, though here and there a red or reddish star may be noticed. It would seem, however, that a very considerable number of stars visible to the naked eye, and which do not attact notice by their colour, are distinctly "red," "reddish," or "orange," when looked at through a telescope. It is possible that in some cases a metallic mirror may have the effect of exaggerating the normal ruddiness of a given star; and this may, to some extent, account for the strong language sometimes used by Sir J. Herschel ("ruby," "carmine," &c.). But making every allowance for merely instrumental effects, the fact seems certain that a telescope of any sort brings out extra colour beyond that which the unaided eye is able to appreciate.

Regarded simply as a spectacle, there can be no doubt that a strongly coloured red star is rather a fascinating object, and so much the more nowadays than formerly in consequence of the undoubted fact that so many variable stars are red, or, to put it the other way, that so many red stars are variable.

Perhaps Espin does not go too far when he makes the broad statement "that almost all the very red stars are variable to a "considerable extent seems to me an established fact."[1]

No attempt has been made to render this catalogue, in the strict sense of the word, exhaustive. It is not a catalogue of all the stars which have been reported in print as red, but only of those which, by a fair concurrence of testimony, may be regarded as entitled to be called such. It, therefore, comprises no more than 584 out of, perhaps, 1500 which have been drawn upon.

1 p. 191.

The following is an enumeration of the catalogues of reputed red stars which have been published up to this date :—

1804. LALANDE, J. DE. *Tables des Étoiles Rouges.*
(*Connaissances des Temps*, An. xv., p. 378.)

1822. DE ZACH, Baron. *Étoiles Rouges.*
(*Corresp. Ast.*, vol. vii., p. 298.)

1847. HERSCHEL, Sir J. *Ruby-coloured or very Intense Red Stars.*
(*Cape Observations*, p. 448.)

1866. SCHJELLERUP, H. C. *Catalog der rothen, isolirten Sterne.*
(*Ast. Nach.*, vol. lxvii., No. 1591, June 18, 1866; Addenda, vol. lxviii., No. 1613, October 30, 1866.)

1872. SCHMIDT, J. F. J. *Verzeichniss rothgelber Sterne.*
(*Ast. Nach.*, vol. lxxx., No. 1902, September 5, 1872.)

1874. SCHJELLERUP, H. C. *Zweiter Catalog der rothen, isolirten Sterne.*
(*Vierteljahrsschrift der Astronomischen Gesellschaft*, vol. ix.)

1876. BURNHAM, S. W. *Catalogue of Red Double Stars.*
(*Month. Not.* vol. xxxvi., p. 331, 1876.)

1877. BIRMINGHAM, J. *Observations and Catalogue of Red Stars.*
(*Trans. Roy. Irish Acad.*, vol. xxvi., p. 249, 1877.)

1877. FEARNLEY. *Des Étoiles colorées.*
(*Ast. Nach.*, vol. lxxxix., No. 2121, March 27, 1877.)

1879. LINDEMANN, E. *Verzeichniss von 42 neuen rothen Sternen.*
(*Bulletin de l'Acad. de St. Pétersbourg*, vol. xxv., p. 155.)

1882. DREYER, J. L. E. *Mean places of 321 Red Stars for 1875.*
(*Dunsink Observations*, pt. iv., 1882.)

1882. HOLDEN, E. S. *Observations of 84 Red Stars and a list of 27 new Red Stars.*
(*Washburn Observatory Publications*, vol. i., p. 161.)

1882. LINDEMANN, E. *Zweites Verzeichniss neuer rother Sternen.*
(*Bulletin de l'Acad. de St. Pétersbourg*, vol. xxviii., p. 278.)

1884. HOLDEN, E. S. *Observations of 119 Red or Coloured Stars.*
(*Washburn Observatory publications*, vol. ii., p. 102.)

1885. ESPIN, Rev. T. E. *Some New Red Stars.*
(*Journal of Liverpool Ast. Soc.*, vol. iii., p. 82, March 1885.)

1886. ESPIN, Rev. T. E. *Some New Red and Orange-red Stars.*
(*Month. Not. R.A.S.*, vol. xlvi., p. 293, March 1886.)

1888. BIRMINGHAM, J., and ESPIN, Rev. T. E. *The Red Stars: Observations and Catalogue.*)
(*Royal Irish Academy*, Cunningham Memoirs, No. 5.)

1893. KRUGER, F. *Catalog der farbigen Sterne zwischen dem Nordpol und 23 Grad Sudlicher Declination.*
(*Publication der Sternwarte* in Kiel, No. viii.)

A few stars have been brought under my notice by private correspondents, and a few have been picked up from various general catalogues where casual mention has been made of this, that, or the other star as being "red." With certain exceptions variable stars have not been included here because I did not wish to trench upon another and very important field of stellar work. The exceptions are in all cases stars of very pronounced colour.

The study of red stars has no very great basis of history behind it. Though, as recorded above, Lalande, De Zach, and (especially) Sir J. Herschel did something in this field, it is to the Danish astronomer, Schjellerup, that the credit is due of making the first comprehensive and organised attempt to bring together red stars into a catalogue by themselves on a large scale. His labours were worthily developed by Birmingham, of Tuam, Ireland, whose catalogue of 1877 remains the most exhaustive ever published. Espin's edition of Birmingham's catalogue contains a large amount of supplementary information, the spectroscopic part of which is of great interest and value. It is, however, matter for regret that Espin's principles of inclusion and exclusion seem to me less intelligible and defined than could have been wished. For instance, he does not include, writing in 1888, a certain number of his own stars put forth in 1885 and 1886 as "red," or "orange red," and no explanation is given of the motives which have prompted such omissions.

As regards the places of the stars, every endeavour has been made to give these with the utmost attainable accuracy so far as information was available. By far the larger number depend upon the *Nautical Almanac*, the *Berliner Astronomisches Jahrbuch*, Dreyer's *Dunsink Catalogue of Red Stars for* 1875, Stone's *Cape Catalogue for* 1880, the *Greenwich Ten-Year Catalogue for* 1880, Stone's *Radcliffe Catalogue for* 1890, Rambaut's *Dunsink Catalogue of* 1101 *Stars for* 1900, and F. Kruger's *Catalog der farbigen Sterne for* 1900.

When these failed, resort was had to Yarnall's *Catalogue for* 1860, Maclear's *Cape Catalogue for* 1850, and the two older *Radcliffe Catalogues*. Outstanding gaps were then filled up by resort to Espin's edition of Birmingham's *Catalogue*, and to a few miscellaneous sources of information which need not be particularised. Some residual uncertainties were kindly cleared up at the last by observations specially made for the purpose by Mr. W. H. Robinson at the Radcliffe Observatory, under the direction of Dr. Rambaut, the Radcliffe Observer, who also contributed a large number of notes on the colours of particular stars observed by himself and various assistants at the Radcliffe Observatory both before and since he was appointed Director.

Many persons have co-operated in accomplishing the results which this Catalogue may be said to bring to a focus, and the frequency with which the names recur in the column of "Remarks," is some index to the industry of the workers. I think that with very few exceptions, every star visible in England to the number of about 500 have been viewed by myself with my 6-in. refractor, and, therefore, I hold myself in some measure responsible for the quality of the work. Others must decide

whether that quality is, on the whole, satisfactory or unsatisfactory. I cannot, however, but regret that no assistance has been rendered to me by any Australian observer, notwithstanding my endeavours to evoke such assistance. The stars in the Southern Hemisphere of greater N.P.D. than about 120°, depend for the most part on observations limited in number and somewhat antiquated in date. I can only hope that the publication of this Catalogue may stimulate some Southern work.

Just a final word on the principles of selection. As a rule, no stars below the 9th magnitude are included, because estimates of colour of stars below that magnitude are apt (I would even say are certain) to be somewhat illusory. The magnitudes in column 7 are in all cases taken from the "Harvard Photometry," where the star was to be found in that exceedingly interesting and important work. The Appendix of "Rejected Stars" is a bare record of what it professes to be. In Espin's edition of Birmingham will be found a large number of stars spoken of as "yellow" or "yellowish," which I did not submit to the Section for treatment, presuming, on Espin's authority, that there could be no pretext for treating them as red stars. This might suggest openings for future work in the domain of red stars.

I have in conclusion to thank the following gentlemen, Members of the Coloured Star Section and others, who have supplied the notes upon which (in addition to my own), this Catalogue is based :—Messrs. T. W. Backhouse, F. A. Bellamy, C. G. Brodie, G. T. Davis, W. H. Robinson, H. M. Whitley, and W. Wickham.

It may be useful for future work if I put on record (*see* next page) the blank form which was sent out to Members of the Section for use by them in recording their observations.

It has been found necessary (through considerations of time and labour involved) to discard some observations sent in grouped in constellations instead of in order of R.A., as requested on the Blank Form.

I have not hitherto taken any steps to deal with coloured stars other than red or orange stars, but an interesting field of work is open in regard to blue and green stars. These are of course very much fewer in number ; still, there are such, and they will repay study and deserve to be systematically catalogued ; and I trust this may ere long be done under the auspices of a new Director.

G. F. CHAMBERS,
Director of the Section.

British Astronomical Association.

COLOURED STAR SECTION.

It will suffice if the "time of observation" is given in hours, and quarters, thus, $8\frac{3}{4}$. The state of the atmosphere should be noted as "Very Clear," "Fairly Clear," "Slightly Hazy," "Very Hazy": "Steady" or "Tremulous" may be added if deemed expedient. If Moonlight or Twilight is obtrusive enough to affect the observations that fact should also be noted, using the words "Slight" or "Considerable," as the case may be. Only Stars which are in the same constellation and of the same *Hour* of R.A. and were observed on the same occasion (be it 1st, 2nd, or 3rd) are to be included in the same form.

R.A._____
(Hour Only).

Colours to be noted thus:

Pale Orange	—O
Decided Orange	—OO
Reddish	—r
Pale Red	—R
Decided Red	—RR
Very Strong Red	—RRR

*Year*_____ *Place*_____ *Power of Eye-Piece*_____

*Name of Observer*_____ *Aperture of Telescope*_____

Constellation _____

NO. OF STAR IN CHAMBERS' CATALOGUE OF 1887: AND NAME, IF IT HAS A DISTINCTIVE NAME.	R.A.	DECL.	*1st Observation.*	*2nd Observation.*	*3rd Observation.*	
						Date of Observation.
						Time of Observation.
						State of Atmosphere.
						Moonlight.
						Twilight.
	h. m. s.	° ′				ANY MISCELLANEOUS REMARKS.

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
1	33 Piscium	0 0 13	+3·1	− 6 15·9	+20·0	4·6	Orange. "Pale orange" (Davis). "Red" (*Uran. Arg.*).	—
2	ι Ceti	0 14 20	+3·0	− 9 22·7	+20·0	3·6	"Pale orange" (Chambers, Davis).	3
3	— Andromedæ	0 14 36	+3·1	+44 9·3	+20·0	8	Fine fiery red	4
4	— Cassiopeiæ	0 29 47	+3·8	+67 22·5	+19·9	6¾	Pale red.	—
5	— Cassiopeiæ	0 31 59	+3·8	+67 5·5	+19·9	7¼	Reddish.	—
6**	δ Andromedæ	0 33 58	+3·2	+30 18·8	+19·7	3·4	Orange. "Pale Orange" (Davis). "Deep yellow" (Whitley).	8
7	α Cassiopeiæ	0 34 50	+3·4	+55 59·3	+19·8	2·2	Fine yellow. "Decided orange, ? var. in depth of tint" (Davis). "Orange yellow" (Whitley).	9
8	β Ceti	0 38 34	+3·0	−18 32·1	+19·8	2·1	Golden yellow. "Pale orange" (Davis).	10
9	Arg. + 61 : 178 Cassiopeiæ.	0 45 17	+3·5	+61 15·6	+19·7	6¼	Fiery orange	Suppl.
10	— Cassiopeiæ	0 46 55	+3·7	+69 25·0	+19·6	7¼	Orange. "Red yellow" (Fearnley).	Suppl.
11	η Ceti	1 3 33	+3·0	−10 42·6	+19·3	3·6	Fine golden yellow. "Pale orange" (Davis).	16
12	β Andromedæ	1 4 8	+3·3	+35 5·5	+19·1	2·2	Red. "Pale orange" (Davis). "Not red" (Whitley).	17
13***	— Piscium	1 10 37	+3·2	+25 14·5	+19·1	7	Fiery red	18
14	— Andromedæ	1 12 3	+3·5	+47 9·3	+19·1	7	Slight tinge of red	20
15	— Cassiopeiæ	1 20 42	+4·0	+65 33·5	+18·9	7	Pale red	23
16	R Sculptoris	1 22 22	+2·7	−33 3·7	+18·7	Var.	"Orange red" (J. Herschel). "Brilliant scarlet" (Gould).	24
17	— Cassiopeiæ	1 26 52	+3·9	+60 7·6	+18·7	9	Decided red. In clus. 103 M.	26
18	α Eridani	1 33 59	+2·2	−57 44·7	+18·4	1	Red	28
19**	ν Piscium	1 36 13	+3·1	+ 4 58·9	+18·3	4·7	Orange. "Decided orange" (Davis).	29
20	— Andromedæ	1 37 30	+3·7	+50 6 5	+18·3	7½	Red	30
21	— Cassiopeiæ	1 48 31	+4·7	+69 42·7	+17·8	8	Fiery red	31
22	Arg. + 44 : 398 Andromedæ.	1 52 33	+3·8	+44 55·6	+17·7	8	Reddish.	—
23	3717 Lal. Ceti	1 55 29	−3·0	− 9 0·5	+17·6	6	Reddish.	—
24	— Persei	1 56 24	+3·9	+54 45·0	+17·6	8	Pale red	33
25**	γ Andromedæ	1 57 45	+3·7	+41 51·0	+17·4	2·2	Orange, with blue companion 10″ distant. "Pale orange; at times decided orange" (Davis). "Orange yellow" (Whitley).	34

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
26**	α Arietis	2 1 32	+3·3	+22 59·4	+17·1	2	Orange. "Pale orange; at times strongly tinted" (Davis). "Pale yellow" (Whitley).	35
27	Arg. + 0 : 352 Ceti	2 1 39	+3·1	+ 0 57·8	+17·3	8	Slight tinge of red. ? mag. ? var.	36
28	60 Andromedæ	2 6 57	+3·7	+43 45·7	+17·0	5·1	Orange. "Decided orange" (Davis).	37
29	— Andromedæ	2 11 48	+3·8	+44 44·8	+16·9	8½	Reddish	39
30**	o Ceti	2 14 18	+3·0	− 3 25·9	+16·7	Var.	Fiery red at and near max. "Deep orange" (Backhouse). "Reddish or pale red" (Davis).	40
31	Arg. + 56 : 583 Persei	2 14 57	+4·2	+56 41·3	+16·8	9	Fiery red. Between clus. 33 and 34 H VI. ? δ	41
32	65 Andromedæ	2 18 56	+3·9	+49 49·6	+16·6	4·9	Good orange. "Decided orange" (Davis).	—
33	Arg. + 65 : 280 Cassiopeiæ.	2 29 25	+4·8	+65 18·6	+15·9	6	Deep orange	45
34	15 Trianguli	2 29 42	+3·6	+34 15·2	+15·9	Var. 5–8	Reddish orange; blue star near. "Decided orange" (Davis).	—
35	Andromedæ	2 31 10	+4·3	+56 36·7	+15·9	8	Pale red	46
36	855 Weisse Trianguli	2 38 0	+3·6	+31 56·8	+15·6	7½	Reddish; neb. h 257 *p*.	47
37	η Persei	2 43 24	+4·3	+55 28·8	+15·1	3·9	Orange. "Decided orange" (Backhouse). "Deep orange" (Whitley).	49
38	Arg. + 63 : 369 Cassiopeiæ.	2 48 9	+4·9	+63 55·5	+14·8	6½	Deep orange	51
39*	α Ceti	2 57 3	+3·1	+ 3 41·8	+14·3	2·7	"Decided orange." (Chambers, Davis). "Orange red" (Robinson). "Orange" (Whitley).	52
40	ω Persei	3 4 38	+3·8	+39 14·0	+13·9	4·7	Reddish yellow. "Pale orange" (Davis).	56
41	Arg. + 47 : 779 Persei	3 5 30	+4·1	+47 21·0	+13·8	7	Pale red; two small stars in the field, *sf*.	57
42	1014 B.A.C. Horologii	3 10 1	+1·5	−57 41·8	+13·6	7	Red	59
43	6048 Lal. Eridani	3 10 40	+2·9	− 9 8·3	+13·6	7	Reddish; *p*. ζ Erid. 18ˢ, and 4′ N.	58
44	W.B. III. 152 Eridani	3 11 25	+2·9	− 6 5·9	+13·6	7	Reddish orange. "Ruddy" (Robinson).	60
45	o Tauri	3 19 26	+3·2	+ 8 40·6	+12·8	3·8	Orange. "Deep yellow" (Davis).	—
46	Arg. + 54 : 685 Camelopardi.	3 22 34	+4·5	+55 1·7	+12·7	7½	Pale red	61

No.	Name of Star.	R.A., 1900, h m s	Prec. in R.A.	Decl., 1900. ° ′	Prec. in Decl.	Mag.	Colour Remarks.	No. in Birm. Cat., 1876.
47	σ Persei - -	3 23 31	+4·2	+47 39·0	+12·7	4·4	Pale orange; contrasts with white stars near. "Decided orange" (Davis).	62
48	— Camelopardi -	3 33 11	+5·1	+62 19·5	+12·1	7	Pale crimson	65
49	Arg.+54 : 110 Camelopardi.	3 33 54	+9	+80 0·2	+12·0	7¾	Red - - -	—
50	— Persei - -	3 38 27	+4·5	+53 35·4	+11·7	8½	Red - - -	67
51	121 P. III. Camelopardi.	3 40 11	+5·4	+65 12·9	+11·7	6	Deep orange. Mag. 4·75 (*Uran. Oxon.*) "Reddish" (Davis).	69
52	π Eridani - -	3 41 24	+2·8	−12 25·1	+11·5	4·4	Reddish orange. "Orange" (Davis).	70
53	42 Espin Tauri -	3 42 8	+3·5	+24 40·8	+11·40	7	Reddish orange.	—
54	1204 B.A.C. Camelopardi.	3 48 36	+5·1	+60 48·0	+11·0	5·1	Pale orange. "Decided orange" (Davis).	71
55	γ Hydri - -	3 48 47	−1·0	−74 32·7	+10·9	3½	"Deep yellow" (Williams).	—
56	7272 Lal. Eridani -	3 50 19	+2·7	−15 13·0	+10·7	8	Reddish orange. A larger star of same colour *sp.*	72
57	γ^1 Eridani - -	3 53 21	+2·8	−13 47·6	+10·4	3·0	Reddish orange. "Decided orange" (Davis). "Reddish" (Robinson).	—
58	Arg.+61 : 667 Camelopardi.	3 57 11	+5·2	+61 31·3	+10·3	7½	Decided red.	—
59	γ Reticuli - -	3 59 27	+0·8	−62 26·3	+10·0	4·7	"Deep yellow" (Williams).	—
60	Arg.+32 : 743 Persei -	4 6 36	+3·8	+32 16·4	+ 9·5	7	Fiery orange.	—
61	19 P. IV. Tauri -	4 9 24	+3·3	+ 9 45·3	+ 9·2	5¼	"Orange or doubtful, may be violet" (Davis). "Red" (*Uran. Arg.*)	—
62	1342 B.A.C. Tauri -	4 16 29	+3·5	+20 35·1	+ 8·9	6½	Fiery orange. ? Var.	74
63	Arg.+34 : 874 Persei -	4 17 46	+3·9	+35 0·8	+ 8·9	7½	Red.	—
64	45 Eridani - -	4 26 45	+3·1	− 0 15·2	+ 8·0	4·9	Deep orange. "Pale orange" (Davis).	—
65	8623 Lal. Eridani -	4 28 38	+2·8	−10 59·8	+ 7·8	6·5	Reddish.	—
66*	47 Eridani - -	4 29 23	+2·9	− 8 26·4	+ 7·8	5½	Reddish orange. "Decided orange" (Davis).	—
67	W.B. IV. 585 Eridani	4 29 24	+2·9	− 9 10·5	+ 7·7	6	Fiery Red.	—
68	*e* (58) Persei -	4 29 44	+4·1	+41 3·5	+ 7·7	4·4	Golden. "Decided orange" (Davis).	80
69**	α Tauri - -	4 30 11	+3·4	+16 18·5	+ 7·4	1	Deep reddish orange. "Decided red" (Backhouse). "Deep yellow" (Whitley).	81
70	Arg.+21 : 1047 Aurigæ	4 38 14	4·2	+43 35·9	+ 7·0	8	Red.	—
71	— Aurigæ -	4 38 46	+3·9	+32 44·0	+ 7·0	8¼	Pale crimson; a larger orange star *p.*	82

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
72*	1457 B.A.C. Camelopardi.	4 40 52	+6·2	+67 59·6	+ 7·0	7	Fiery red	83
73	Arg.+34 : 911 Aurigæ	4 42 38	+3·9	+34 49·5	+ 6·7	8	Red.	—
74	— Aurigæ	4 45 14	+3·7	+28 21·4	+ 6·5	8	Unmistakeably crimson.	85
75	Arg.+38 : 955 Aurigæ	4 45 47	+4·1	+38 20·0	+ 6·5	8½	Red.	—
76	o^1 Orionis	4 46 53	+3·4	+14 5·1	+ 6·4	5·4	Reddish orange. "Decided orange" (Backhouse; Davis). "Orange" (Whitley).	87
77	5 Orionis	4 48 8	+3·1	+ 2 20·6	+ 6·3	6	Deep orange. Probably var. "Decided orange" (Davis).	88
78	236 P. IV. Orionis	4 49 22	+3·2	+ 7 37·1	+ 6·2	6	Deep golden yellow	89
79	6 Aurigæ	4 53 29	+4·1	+39 30·4	+ 6·0	6½	Red	91
80	3 Espin Aurigæ	4 53 44	+4·1	+40 5·6	+ 6·0	7½	Fiery red, ? identity.	—
81**	R Leporis	4 55 3	+2·7	−14 57·7	+ 5·7	Var.	Decided crimson. "Crimson" (Wickham).	94
82	ζ Aurigæ	4 55 49	+4·2	+40 55·8	+ 5·7	4·0	Fine deep orange. "Orange" (Whitley). "Not deep orange" (Davis).	93
83	Arg.+34 : 946 Aurigæ	4 59 49	+3·9	+34 43·1	+ 5·4	8½	Reddish.	—
84	899 H.P. Orionis	5 0 14	+3·1	+ 1 2·4	+ 5·3	7	Intense fiery red	96
85	ε Leporis	5 1 13	+2·5	−22 30·3	+ 5·0	3·3	Reddish orange, ? var.	97
86	W.B. V. 29 Orionis	5 4 53	+3·2	− 5 39·2	+ 4·7	8	Full red	99
87*	9785 Lal. Leporis	5 6 43	+2·8	−11 58·4	+ 4·6	6½	Deep red. "Decidedly red" (Robinson). Espin and Gore's places are irreconcileable. This place is from *Rad. Cat.* of 1890.	—
88	Arg. −0 : 890 Orionis	5 9 31	+3·0	− 0 41·1	+ 4·4	7	Pale orange	102
89*	Arg.+40 : 1245 Aurigæ	5 11 55	+4·2	+40 58·8	+ 4·2	7½	"Red-orange" (Robinson). "Decided orange" (Davis).	—
90	Arg.+35 : 1046 Aurigæ	5 12 28	+4·0	+35 40·5	+ 4·2	8½	Fiery red.	—
91	— Aurigæ	5 13 10	+4·1	+39 14·3	+ 4·2	8	Pale red, ? var. in colour.	103
92	9919 Lal. Aurigæ	5 14 14	+4·0	+34 10·0	+ 4·1	8½	Reddish	104
93	Arg.+32 : 957 Aurigæ	5 15 18	+3·9	+32 24·3	+ 3·6	9	"Very red" (Espin).	—
94	61 P. V. Orionis	5 16 50	+3·1	+ 3 28·4	+ 3·7	8	Red	106
95*	Arg.−10 : 1178 Orionis	5 20 18	+2·8	−10 25·1	+ 3·5	6	Reddish orange. "Reddish" (Davis).	—
96*	Arg.+29 : 897 Aurigæ	5 20 46	+3·8	+29 50·3	+ 3·5	8	Almost pale ruby.	—
97	— Aurigæ	5 21 17	+3·9	+35 13·9	+ 3·4	7	Good orange. In clus. 39 ♅ VII.	—
98	117 Tauri	5 22 13	+3·5	+17 9·5	+ 3·3	6·5	Red.	—

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour : Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
99	S Orionis - -	5 24 4	+2·9	− 4 46·3	+ 3·0	Var.	Reddish. In centre of small equilateral triangle of 3 stars.	109
100	31 Orionis - -	5 24 38	+3·0	− 1 10·2	+ 3·2	4·9	Deep orange. Var. 5-6? "Decided orange" (Davis). "Orange" (Whitley).	110
101	119 Tauri - -	5 26 20	+3·5	+18 31·2	+ 3·0	4·6	Pale red. "Distinctly red" (*Uran. Oxon.*). "Decided orange or pale red" (Davis).	111
102*	Arg.+32 : 1030 Aurigæ	5 27 11	+3·9	+32 40·5	+ 3·0	7	Reddish orange. Blue star, mag. 6, near.	—
103	10426 Lal. Orionis -	5 27 30	+3·0	− 0 3·6	+ 2·8	8	Decided red. "Red" (Robinson). ? mag. too small. *Rad. Cat.* of 1890 gives 6-7, and other authorities differ much.	—
104*	Arg. + 7 : 929 Orionis	5 27 49	+3·2	+ 7 4·3	+ 2·8	7½	Very red.	—
105	Arg. + 25 : 863 Tauri	5 28 39	+3·7	+25 49·5	+ 2·7	8½	Red.	—
106	10483 Lal. Orionis -	5 29 0	+3·0	− 1 32·3	+ 2·7	7	Fiery red.	—
107	ϕ^2 Orionis - -	5 31 24	+3·3	+ 9 14·2	+ 2·5	4·4	Orange. "Decided orange" (Davis). "Yellow" (Whitley).	113
108	− Orionis - -	5 31 30	+3·3	+10 58·6	+ 2·5	7	Reddish orange -	114
109	β Doradûs - -	5 32 45	+0·5	−62 33·3	+ 2·4	3·9	"Reddish yellow" (Williams).	—
110	124 Tauri - -	5 33 10	+3·6	+23 15·6	+ 2·4	7½	Quadruple star: A, red.	—
111	Arg.+31 : 1049 Aurigæ	5 34 11	+3·8	+31 51·8	+ 2·3	6½	"Orange red" (Espin).	—
112	Arg.+31 : 1058 Aurigæ	5 35 42	+3·9	+31 49·5	+ 2·2	8½	Fiery red.	—
113	10743 Lal. Orionis -	5 35 59	+3·0	− 3 53·7	+ 2·2	8	Reddish - -	117
114	51 Orionis - -	5 37 19	+3·1	+ 1 25·6	+ 2·0	5½	Orange. "Slightly red" (*Uran. Oxon.*) "Pale orange" (Backhouse, Davis).	119
115	− Tauri - -	5 39 6	+3·7	+24 22·6	+ 2·0	8½	Decided red, ? var. -	120
116	Arg.+50 : 1225 Aurigæ	5 39 32	+4·6	+50 2·9	+ 1·9	7	Reddish orange.	—
117	− Geminorum -	5 39 43	+3·6	+20 39·2	+ 1·7	7½	Good red, ? var. -	121
118	− Pictoris - -	5 40 27	+1·7	−46 29·9	+ 1·7	8	"Vivid red" (J. Herschel)	124
119	− Aurigæ - -	5 41 42	+3·9	+30 35·7	+ 1·7	8	Deep red. Probably var. in mag. and colour.	123
120	11061 Lal. Orionis -	5 44 53	+3·1	+ 4 24·1	+ 1·2	6	Deep orange.	—
121	Arg.+32 : 1109 Aurigæ	5 44 55	+3·9	+32 5·9	+ 1·2	6½	Fiery red. Near neb. 37 M.	—
122	56 Orionis - -	5 47 14	+3·0	+ 1 49·9	+ 1·0	5·0	Reddish orange. "Decided orange" (Davis).	—
123	Arg.+53 : 962 Aurigæ	5 47 30	+4·8	+53 26·4	+ 1·0	8	Red. = 58 Espin.	—

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		h m s	s	° ′	″			
124	Arg.+10: 927 Orionis	5 48 41	+3·3	+10 33·7	+ 1·0	6½	Golden yellow -	126
125	α Orionis - -	5 49 45	+3·2	+ 7 23·3	+ 0·9	0·9	Reddish orange. "Pale orange" (Davis). "Decided red" (Backhouse). "Reddish" (Robinson). "Deep yellow" (Whitley). Var.?	127
126	Gore's *Nova* Orionis	5 49 53	+3·6	+20 9·3	+ 0·9	6½	Fiery red. "Very red at times" (Wickham). ? Var. in colour.	—
127	δ Aurigæ - -	5 51 17	+4·9	+54 16·6	+ 0·9	3·3	"Pale orange" (Davis). "Deep yellow" (Whitley).	129
128*	π Aurigæ - -	5 52 29	+4·4	+45 55·7	+ 0·8	4·5	Reddish orange. "Pale orange" (Brodie). "Decided orange" (Davis). "Deep orange" (Whitley).	130
129	11451 Lal. Orionis -	5 57 12	+2·9	− 5 8·2	+ 0·3	7	Reddish yellow -	133
130	Arg.+47: 1258 Aurigæ	6 2 46	+4·5	+47 43·0	− 0·3	8	Red. = 158 Espin.	—
131	1970 B.A.C. Geminorum.	6 3 30	+3·6	+22 12·5	− 0·3	6·5	"Reddish" (Robinson).	—
132*	11684 Lal. Geminorum	6 4 39	+3·7	+26 2·1	− 0·3	7½	Good red - - -	135
133	Arg.+21: 1146 Geminorum.	6 5 51	+3·6	+21 53·5	− 0·3	7	Red - -	136
134	Arg.+22: 1220 Geminorum.	6 6 16	+3·6	+22 55·6	− 0·3	7	Red. Two red stars here. The smaller (mag. 7·7) precedes this one by 23 s. and is 18′ N.	137
135	η Geminorum -	6 8 51	+3·6	+22 38·2	− 0·7	3·5	Reddish yellow. "Pale orange" (Davis). "Orange" (Whitley). Var.	139
136	Arg.+17: 1191 Orionis	6 10 35	+3·5	+17 12·9	− 0·9	6·5	Orange. "Reddish" (Robinson).	—
137	Arg.+33: 1290 Aurigæ	6 10 39	+3·9	+33 14·5	− 0·9	9	Very red.	—
138	Arg.+39: 1576 Aurigæ	6 10 47	+4·2	+39 30·4	− 0·9	7½	Pale red. ? Var. -	141
139	12060 Lal. Canis Majoris.	6 13 15	+2·7	−16 46·7	− 1·1	5·1	Red. "Pale orange" (Davis).	—
140	2029 B.A.C. Geminorum.	6 13 18	+3·6	+23 18·9	− 1·1	7	Pale orange. "Magnificent spectrum."	—
141	12057 Lal. Orionis -	6 14 22	+3·4	+14 41·6	− 1·3	6	Reddish yellow -	142
142	12104 Lal. Orionis -	6 14 59	+3·0	− 2 54·1	− 1·3	6	Deep orange. "Decided orange" (Davis). ? Var.	—
143	Σ 895 Monocerotis -	6 15 27	+3·1	+ 5 47·1	− 1·4	8	Fairly red. "Orange red" (Robinson). *Comes*, Mag. 9·5, deep blue.	—
144	12169 Lal. Canis Majoris.	6 16 26	+2·8	−11 46·3	+ 1·4	7	Fiery red. Good contrast with 12176 Lalande (mag. 6) which follows 20ˢ, and 5′ N. (Robinson).	—

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		h m s	s	° ′	″			
145	160 Espin Aurigæ -	6 16 28	+4·5	+47 43·5	− 1·4	8½	"Red and probably var" (Espin).	—
146	μ Geminorum -	6 16 55	+3·6	+22 33·9	− 1·6	3·2	Reddish orange. "Decided orange" (Davis). "Orange" (Whitley).	143
147	Arg.+25: 1250 Geminorum.	6 17 51	+3·7	+25 4·9	− 1·6	9	Very red. "Red" (Robinson).	—
148	5 Lyncis - - -	6 18 4	+5·2	+58 28·5	− 1·6	5·5	Fiery red. In a good group. "Decided orange" (Davis).	—
149	3 Canis Majoris -	6 18 28	+2·2	−33 23·7	+ 1·6	4·1	"Rich orange yellow" (Tupman).	—
150	— Canis Majoris -	6 19 40	+2·4	−27 0·8	− 1·6	8	Pale crimson. "Intense ruby" (J. Herschel). "Orange red" (Brodie).	145
151	— Geminorum -	6 19 45	+3·4	+14 46·6	− 1·6	7	Full deep orange. ? var.	144
152	12359 Lal. Monocerotis	6 22 0	+2·9	− 4 24·0	− 1·8	7	Deep orange. "Reddish?" (Robinson).	—
153	— Monocerotis -	6 25 26	+3·0	− 2 57·2	− 2·1	8	Orange. ? var.	147
154	12524 Lal. Canis Majoris.	6 25 50	+2·6	−19 8·8	− 2·2	6½	Orange. "Reddish" (Bellamy).	—
155	12545 Lal. Monocerotis	6 27 2	+2·9	− 8 5·2	− 2·3	5½	Reddish orange. "Decided orange" (Davis).	—
156	Arg.+16: 1194 Geminorum.	6 28 38	+2·7	+16 9·1	− 2·4	9	"Strikingly red" (Robinson).	—
157**	2139 B.A.C. Aurigæ -	6 29 39	+4·1	+38 31·6	− 2·4	6	Deep fiery red -	148
158	Arg.−1: 1288 Monocerotis.	6 30 8	+3·0	− 1 25·6	− 2·4	8¼	Fiery red. = 165 Espin	—
159	21 Espin Aurigæ -	6 31 21	+1·9	+39 29·0	− 2·6	6½	Reddish orange.	—
160	ν^2 Canis Majoris -	6 31 53	+2·6	−19 10·2	− 2·8	4·2	Orange. "Pale orange; uncertain" (Davis). "Red" (Robinson). "Deep yellow" (Whitley).	—
161	2196 B.A.C. Puppis -	6 36 10	+1·3	−52 50·7	− 3·1	6	"De Color rojizo" (Moesta).	150
162	12907 Lal. Monocerotis	6 37 10	+2·9	− 9 4·2	− 3·1	5½	"Orange. "Decided orange" (Davis).	151
163	ε Geminorum -	6 37 46	+3·7	+25 13·8	− 3·3	3·2	Golden yellow. "Decided orange" (Davis). "Yellow" (Whitley).	152
164	17 Monocerotis -	6 41 55	+3·3	+ 8 8·7	− 3·4	5	Reddish yellow. "Decided orange" (Davis).	—
165	— Canis Majoris -	6 42 44	+2·6	−20 33·3	− 3·5	8	Pale red. Near centre of clus. 41 M.	153

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		h m s	s	° ′	″			
166*	13100 Lal. Monocerotis	6 42 51	+ 2·9	− 8 53·3	+ 3·7	5½	Reddish orange. "Decided orange" (Davis). "Reddish" (Robinson).	—
167	Arg.+61 : 915 Lyncis	6 44 31	+ 5·4	+61 8·8	− 3·7	8	Red.	—
168	θ Canis Majoris -	6 49 32	+ 2·8	−11 54·8	− 4·3	4·2	Reddish orange. "Decided orange" (Davis). "Red" (Robinson). "Deep yellow" (Whitley).	156
169	o^1 Canis Majoris -	6 49 59	+ 2·5	−24 3·5	− 4·3	4·0	Deep orange - -	157
170	1228 Groom. Camelop.	6 50 0	+ 6·8	+70 56·6	− 4·3	6	"Orange" (Robinson).	—
171	μ Canis Majoris -	6 51 31	+ 2·7	−13 54·8	− 4·4	5·2	Fiery red. "Decided orange or reddish" (Davis).	158
172	2289 B.A.C. Puppis -	6 53 36	+ 1·6	−48 35·3	− 4·6	5·5	"De Color rojizo" (Moesta).	161
173	51 (Hev.) Cephei -	6 53 45	+29·7	+87 12·3	− 4·7	5·3	Full orange. "Pale orange" (Davis).	154
174	1245 Groom. Camelop.	6 54 32	+ 6·8	+70 52·6	− 4·5	6½	Pale red - -	160
175	13627 Lal. Monocerotis	6 57 2	+ 2·9	− 5 34·9	− 4·9	5½	Good orange. "Decided orange" (Davis). ? Var.	—
176	22 Canis Majoris -	6 57 44	+ 2·4	−27 47·5	− 5·0	3·5	Fiery red. ? Var. -	162
177	− Monocerotis - -	6 57 57	+ 2·9	− 8 18·4	− 4·9	8	Red. In clus. 50 M. -	163
178**	− Monocerotis -	7 2 5	+ 2·9	− 7 24·1	− 5·3	8	Crimson - -	165
179*	R Canis Minoris -	7 3 13	+ 3·3	+10 10·9	− 5·3	7–10 var.	Red - - -	167
180*	− Canis Majoris -	7 3 23	+ 2·8	−11 46·5	− 5·4	7½	Decided red - -	166
181	14038 Lal. Geminorum	7 9 35	+ 3·6	+22 8·5	− 5·9	7	Orange or pale red -	170
182	2326 B.A.C. Camelopardi.	7 10 4	+13·0	+82 36·3	− 5·6	5·3	Reddish orange. "Decided orange" (Davis).	168
183	L^2 Puppis - -	7 10 28	+ 1·8	−44 28·7	− 6·0	5	"Red and var." (*Uran. Arg.*)	—
184	14200 Lal. Canis Majoris.	7 12 23	+ 2·5	−23 8·2	− 6·2	6½	Wide pair. A, 6½ orange; B, 7 blue. "A, probably var." (Espin).	—
185	14184 Lal. Monocerotis	7 12 39	+ 2·9	− 6 30·1	− 6·2	6½	Reddish orange. "Reddish" (Robinson.)	—
186	π Argûs - -	7 13 36	+ 2·1	−36 55·0	− 6·3	2·7	"Beautiful orange" (Gore). "Very rich yellow" (Tupman).	171
187	−Monocerotis -	7 16 14	+ 2·8	−10 11·9	−6·5	8	Orange. "Pale orange" (Davis). *p* clus., h 443. ? δ too little.	172
188	66 Aurigæ - -	7 17 13	+ 4·0	+40 52·0	−6·3	5·3	Orange.	—
189	−Canis Majoris -	7 18 52	+ 2·5	−25 34·5	−6·7	7	Red - - -	175
190	η Canis Majoris -	7 20 8	+ 2·3	−29 6·5	−6·9	2·4	"? Purple" (Tupman). "Pale red" (Smyth).	—

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191	Arg.+46: 1271 Lyncis	7 20 56	+4·4	+46 10·2	−6·9	8	Fiery red.	—
192	14503 Lal. Canis Majoris.	7 21 28	+2·6	−20 45·4	−6·9	8	Reddish - -	176
193	14599 Lal. Monocerotis.	7 24 37	+2·8	−10 7·2	−7·2	6	Reddish orange, ? var.	178
194	σ Argûs - -	7 26 3	+1·9	−43 5·9	−7·3	3·5	"Red" (Schmidt) -	179
195*	14776 Lal. Puppis -	7 29 12	+2·7	−14 18·4	−7·6	5·0	Fiery red. *p* a brilliant field. "Decided orange" (Davis).	—
196	υ Geminorum -	7 29 45	+3·7	+27 7·2	−7·6	4·2	Orange. "Decided orange" (Davis). "Deep orange-yellow" (Whitley).	181
197	25 Espin Lyncis -	7 30 19	+4·1	+40 14·5	−7·6	7	Reddish. The *p* star of a curious curve of 5 stars.	—
198	14952 Lal. Puppis -	7 34 53	+2·7	−16 37·0	−8·0	6	Pale red.	—
199	Arg.+23: 1780 Geminorum.	7 34 56	+3·6	+23 16·0	−7·9	6	Fiery red - -	182
200	−Canis Minoris -	7 35 33	+3·2	+ 4 18·3	−8·1	7	Reddish - orange. "Light orange" (Robinson).	—
201	γ Monocerotis -	7 36 28	+2·9	− 9 19·0	−8·2	4·2	Orange. "Pale orange" (Davis). "Reddish" (Robinson).	—
202	σ Geminorum -	7 37 3	+3·7	+29 7·5	−8·2	4·1	"Pale orange" (Chambers, Davis). "Orange" (Whitley). A small star *p* 39°.	183
203	15018 Lal. Monocerotis.	7 37 32	+2·8	−10 38·7	−8·2	7½	Pale red - -	186
204	Arg.+5: 1759 Canis Minoris.	7 38 4	+3·2	+ 5 10·8	−8·3	7	Pale red - -	187
205*	β Geminorum -	7 39 12	+3·7	+28 16·1	−8·4	1·1	"Pale orange" (Chambers, Davis). "Yellow" (Whitley).	188
206	*c* Puppis - -	7 41 40	+2·1	−37 43·5	−8·5	3·6	"Orange" (J. Herschel). The chief star in neb. h 3099 ? Var.	189
207	28 Espin Lyncis -	7 43 23	+4·0	+40 1·4	−8·6	7	Good red.	—
208	Arg.+5: 1797 Canis Minoris.	7 43 27	+3·2	+ 5 40·4	−8·6	9	Good red.	—
209	ξ Argûs - -	7 45 5	+2·5	−24 36·5	−8·9	3·4	Good orange.	—
210	−Velorum - -	7 53 32	+1·7	−49 42·9	−9·5	8	"Brick red inclining to orange."	194
211	−Carinæ - -	7 56 42	+1·0	−60 34·9	−9·7	8	"Orange." In neb. h 3111: "Near it a ruddy star" (J. Herschel).	195
212	2704 B.A.C. Lyncis -	8 1 52	+5·0	+58 33·0	−10·2	6	Orange - -	196
213	ρ Argûs - -	8 3 17	+2·6	−24 1·0	−10·3	2·9	Reddish (Robinson).	—

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214*	β Cancri - -	8 11 5	+3·2	+ 9 29·6	−10·9	3·8	Reddish orange. "Pale orange" (Davis). "Reddish yellow" (Robinson). "Deep yellow" (Whitley).	—
215	16320 Lal. Hydræ -	8 14 53	+3·1	+ 3 4·8	−11·1	8½	Very red. "Vividly red" (Bellamy).	—
216	2820 B.A.C. Puppis -	8 19 35	+2·2	−37 57·9	−11·4	6	"De Color rojizo" (Moesta).	201
217	ε Argûs - -	8 20 28	+1·2	−59 11·2	−11·5	21	"Yellow: orange" (Tupman).	—
218	72 P. VIII. Puppis -	8 20 44	+2·6	−23 43·3	−11·5	5½	"Orange" (Tupman).	—
219	17091 Lal. Hydræ -	8 34 10	+2·7	−19 23·1	−12·4	6½	Reddish - -	205
220	3449 Lac. Mali -	8 35 30	+2·5	−28 43·7	−12·5	7	Orange.	—
221	δ Cancri - -	8 39 0	+3·4	+18 31·3	−13·0	4·3	Orange. "Reddish" (Robinson).	—
222	Arg. 8952 Mali -	8 41 17	+2·5	−27 50·3	−13·0	8½	Red - - -	206
223	— Puppis - -	8 46 34	+2·0	−47 59·6	+13·3	8½	"Ruby coloured" (J. Herschel).	208
224	17497 Lal. Cancri -	8 47 38	+3·4	+19 42·0	−13·3	8½	Red - - -	209
225	3029 B.A.C. Cancri -	8 49 45	+3·4	+17 36·7	−13·4	7	Pale crimson - -	211
226	17624 Lal. Cancri -	8 49 50	+2·9	−10 59·8	−13·5	7½	Pale red. A blue star with a companion follows.	213
227	60 Cancri - -	8 50 28	+3·3	+12 1·2	−13·5	6–8	Reddish orange," Probably var."	212
228	σ^1 Ursæ Majoris -	8 59 38	+5·3	+67 16·5	−14·1	4·8	Deep orange. "Decided orange" (Davis).	—
229	ω Hydræ - -	9 0 44	+3·2	+ 5 29·5	−14·2	5·6	Deep orange. "Pale orange" (Davis).	—
230	3121 B.A.C. Mali (κ Pyxis).	9 2 34	+2·6	−25 27·3	−14·3	4·8	Red - - -	217
231	λ Argûs - -	9 4 19	+2·2	−43 1·6	−14·4	2·5	"Orange" (Tupman). "Blood red" (Pope).	—
231	Arg.+31: 1946 Cancri	9 4 35	+3·6	+31 22·3	−14·3	6½	Fiery red. ? Var. -	218
232	π^2 Cancri - - -	9 9 43	+3·3	+15 21·5	−14·8	5¾	"Pale orange" (Chambers; Davis). The *p* star of a curious group of four.	219
233	*g* Carinæ - - -	9 13 23	+1·7	−57 7·4	−15·0	4·5	"Deep orange red" (Tupman).	—
234	α (40) Lyncis - -	9 14 58	+3·7	+34 48·9	−15·0	3·4	Reddish orange. "Decided orange" (Davis). A small blue star 12^s *nf*.	220
235	Arg.+0: 2499 Hydræ	9 15 29	+3·1	+ 0 35·7	−15·1	7	Reddish - - -	221
236	α Hydræ - - -	9 22 40	+2·9	− 8 13·5	−15·4	2·0	"Reddish yellow" (Chambers; Robinson). "White in 1889" (Whitley). "Decided orange" (Davis). Possibly var.	223

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		h m s	s	° ″	″			
237	18688 Lalande Hydræ	9 24 36	+2·8	−20 18·4	−15·4	6	Fiery red. "Red" (Bellamy).	—
238	λ Leonis - - -	9 26 1	+3·4	+23 24·6	−15·6	4·4	Reddish orange. "Decided orange" (Davis). "Yellow" (Whitley). "Slightly red" (*Uran. Oxon.*).	224
239	N Velorum - -	9 28 11	+1·8	−56 35·6	−15·8	3·2	"Very rich yellow" (Tupman).	—
240	R Carinæ - -	9 29 44	+1·5	−62 20·7	−15·9	8	"Sanguine red" (J. Herschel). Var.	225
241	— Ursæ Majoris -	9 31 11	+5·0	+67 43·4	−15·9	7	Orange. ? Var. in colour.	—
242	ι Hydræ - -	9 34 45	+3·1	− 0 41·3	+16·1	4·2	"Orange" (Chambers; Robinson). "Pale orange" (Davis).	226
243	ε Leonis - - -	9 40 10	+3·4	+24 14·1	−16·4	3·1	"Pale orange" (Chambers, Davis). "Reddish yellow" (Robinson). "Yellow" (Whitley).	—
244	R Leonis - -	9 42 11	+3·3	+11 53·6	−16·5	Var. 5–10	Pale crimson. "Reddish" (Davis). "Fiery red" (Whitley).	228
245	*l* Carinæ - -	9 42 30	+1·6	−62 2·8	−16·5	3¾	"Yellow; orange" (Tupman). Var.	—
246*	Ö-A(2) 10163 Hydræ	9 46 28	+2·8	−22 33·0	−16·7	7	Good red. "Distinctly red" (Bellamy).	229
247	μ Leonis - -	9 47 4	+3·4	+26 28·7	−16·8	4	Pale orange. "Yellow" (Robinson).	—
248	2412 Rad. Ursæ Majoris.	9 49 41	+4·1	+54 43·2	−16·9	7	Dark orange.	—
249	— Velorum - -	9 50 21	+2·5	−41 6·7	−17·2	7½	"Scarlet" (J. Herschel).	230
250	π Leonis - -	9 54 55	+3·1	+ 8 31·5	−17·1	5·0	Reddish orange. "Pale orange" (Davis). "Orange red" (Robinson). "Yellow" (Whitley).	231
251	19580 Lal. Sextantis -	9 55 55	+3·0	− 2 42·5	−17·1	7	Reddish. "Doubtful, if red" (Robinson).	—
252	19620 Lal. Hydræ -	9 57 6	+2·7	−23 19·5	−17·2	7	Reddish. "Slightly reddish" (Bellamy).	—
253	5436 Stone Carinæ -	9 57 53	+1·9	−59 48·7	−17·2	8½	"Scarlet" (J. Herschel).	232
254	19637 Lal. Sextantis -	9 57 55	+3·0	− 5 8·1	+17·2	7	Reddish. "Reddish yellow" (Robinson).	—
255	A (31) Leonis -	10 2 35	+3·2	+10 29·3	−17·5	4·6	Orange. "Decided orange" (Davis). "Orange yellow" (Whitley).	233
256	18 Sextantis - -	10 5 58	+3·0	− 7 55·5	−17·6	5¾	Reddish orange. "Pale orange" (Davis). "Orange" (Robinson). ? Var.	234

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ″	″			
257	5536 Stone Antliæ	10 7 30	+2·6	−34 49·8	−17·7	7	"Scarlet" (J. Herschel).	235
258	— Carinæ	10 11 2	+2·0	−60 11·5	−17·8	9	"Ruby red"	236
259	Arg.+42: 2108 Ursæ Majoris.	10 11 23	+3·6	+42 18·0	−17·8	6½	Fiery orange. "? Var."	—
260	*q* Carinæ	10 13 44	+2·0	−60 50·0	−17·9	3·3	"Orange red" (Tupman).	—
261	V Velorum	10 15 51	+2·2	−54 31·6	−17·9	3·4	"Red" (Tupman). "? Var."	
262	*μ* Ursæ Majoris	10 16 22	+3·6	+42 0·1	−18·0	3·1	Orange. "Decided orange" (Davis). "Yellow" (Whitley).	238
263	*μ* Hydræ	10 21 15	+2·9	−16 19·5	−18·2	4·1	Reddish orange. "Decided orange" (Davis).	239
264	*s* Carinæ	10 24 12	+2·2	−58 13·7	−18·3	4·6	"Yellow; Orange" (Tupman).	—
265	4367 Lac. Carinæ	10 28 42	+1·4	−72 42·4	−18·4	5·6	"Deep orange" (Tupman).	—
266	3630 B.A.C. Antliæ	10 30 47	+2·7	−39 2·7	−18·4	6½	"Orange; almost scarlet" (J. Herschel).	240
267	*r* Carinæ	10 31 45	+2·3	−57 2·4	−18·4	5·3	"Orange red" (Tupman).	241
268**	3637 B.A.C. Hydræ	10 32 36	+3·0	−12 51·8	−18·5	5·4	Fiery red. "Pale orange" (Davis). "Var., beyond question" (Gould). "Very conspicuously coloured" (Robinson).	242
269	t^2 Carinæ	10 34 56	+2·3	−58 39·7	−18·6	5·2	"Deep orange red" (Tupman).	—
270	Arg. + 68: 617 Ursæ Majoris.	10 38 8	+4·2	+67 56·2	−18·7	6	Good pale red.	—
271	4435 Lac. Carinæ	10 38 48	+2·3	−58 41·5	−18·7	6	"Red" (Brisbane).	—
272	*w* (4446) Lac. Carinæ	10 39 44	+2·3	−60 2·5	−18·8	6	"Red" (Brisbane). "Deep orange red" (Tupman).	245
273	*η* Argûs	10 41 10	+2·3	−59 9·5	−18·9	Var	"Orange" (Tupman)	247
274	*μ* Argûs	10 42 28	+2·6	−48 53·5	−18·9	2·9	"Very red" (Tupman).	—
275	20891 Lal. Sextantis	10 45 0	+3·0	− 2 33·7	−19·0	6½	Pale orange. "Orange" (Robinson). "Very red" (Robinson).	—
276	20918 Lal. Hydræ	10 46 45	+2·9	−20 43·2	−19·0	7	Crimson. "Very red" (Robinson).	248
277	*u* Carinæ	10 49 25	+2·4	−58 19·3	−19·0	4·1	"Bright orange red" (Tupman).	—
278	Arg. + 23: 2279 Leonis.	10 50 44	+3·2	+22 53·1	−19·0	7	Orange.	—
279	*α* Crateris	10 54 54	+2·9	−17 46·0	−19·2	4·1	Orange. "Pale orange" (Davis). "Red" (Robinson).	—

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No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
280	R Crateris - -	10 55 40	+3·0	−17 47·2	−19·2	Var. 8–9	Orange. In the field with α Crateris.	250
281	ψ Ursæ Majoris -	11 4 2	+3·4	+45 2·5	−19·4	3·1	Reddish. "Pale orange" (Davis). "Yellow" (Whitley).	254
282	x Carinæ - -	11 4 19	+2·5	−58 26·0	−19·4	4·6	"Deep orange red" (Tupman).	—
283	— Chamæleontis -	11 5 40	+1·0	−81 14·1	−19·5	8	"Ruby" (J. Herschel)	255
284	72 Leonis - -	11 9 53	+3·2	+23 38·4	−19·5	4·9	Reddish yellow. "Decided orange," "orange yellow" (Whitley).	256
285**	ν Ursæ Majoris - -	11 13 4	+3·2	+33 38·4	−19·5	3·8	Deep golden yellow. "Pale orange" (Davis).	—
286	ζ Crateris - -	11 14 20	+3·0	−14 14·2	−19·4	3·9	Reddish yellow. "Pale orange" (Davis). "Orange red" (Robinson).	—
287	87 Leonis - -	11 25 12	+3·1	− 2 27·1	−19·8	5·0	Orange (Chambers, Whitley). "Decided orange or reddish" (Davis).	261
288	λ Draconis - -	11 25 28	+3·6	+69 53·0	−19·8	4·1	Orange. "Decided orange" (Davis).	262
289	υ Leonis - -	11 31 50	+3·0	− 0 16·3	−19·8	4·5	Reddish yellow. "Pale orange" (Davis). "Red" (Wickham). "Orange yellow" (Whitley).	—
290	ω Virginis - -	11 33 18	+3·1	+ 8 41·3	−19·9	5·5	"Pale orange" (Chambers, Davis). "Red" (*Uran. Arg.*).	—
291	22104 Lal. Crateris -	11 34 46	+3·0	−16 4·0	−19·9	6	Red. "Reddish" (Robinson).	—
292	— Muscæ - -	11 35 0	+2·6	−72 0·3	−19·9	8½	"Fine ruby" (J. Herschel).	264
293	22122 Lal. Leonis -	11 35 59	+3·1	+25 21·6	−19·9	8	Reddish yellow -	
294	32 Ursæ Majoris -	11 39 9	+3·2	+49 4·3	−19·9	8	Red.	—
295	χ Ursæ Majoris -	11 40 46	+3·2	+48 20·0	−19·9	3·9	Golden. "Decided orange" (Davis). "Yellow" (Whitley).	266
296	3993 B.A.C. Muscæ -	11 43 25	+2·8	−66 15·5	−20·0	5·3	"Red" (Tupman).	—
297	— Centauri - -	11 45 7	+2·9	−56 29·4	−20·0	8	"Orange," about 10′ N. of neb. h 3365 (J. Herschel).	268
298	203 P. XI. Virginis -	11 53 6	+3·0	+ 4 2·3	−20·0	8	Red. ? mag. too small. 208 P. Mag. 5½ follows by 1 m. 43 s. and 10½′ N.	269
299	1845 Groom. Ursæ Maj.	11 55 47	+4·0	+81 24·7	−20·0	6	Reddish - - -	270
300	5032 Lac. Crucis -	12 3 10	+3·0	−60 17·4	−20·0	6	"Red" (Stone).	—
301	ε Corvi - -	12 4 58	+3·0	−22 3·8	−20·0	3·1	Reddish orange. "Reddish" (Robinson). "Deep orange yellow" (Whitley). ? Var.	272

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
302	ϵ Muscæ - -	12 12 10	+3·2	−67 24·2	−20·0	4·7	"Orange red" (Tupman).	—
303	ϵ Crucis - - -	12 15 32	+3·2	−59 50·9	−20·0	4.0	"Orange" (Tupman).	—
304**	− Virginis - -	12 20 6	+3·0	+ 1 19·4	−20·0	8½	Good crimson. ? Var.	277
305	71 Ursæ Majoris -	12 20 17	+2·9	+57 16·6	−20·0	5½	Good orange. "Pale Orange" (Davis).	—
306	γ Comæ Berenicis -	12 21 57	+3·0	+28 49·5	−20·0	4·7	Deep golden yellow. "Pale orange" (Davis).	279
307	− Virginis - -	12 25 14	+3·0	+ 4 58·2	−19·9	8½	Deep red - -	281
308	γ Crucis - -	12 25 37	+3·3	−56 33·2	−19·9	2·0	"Clear orange yellow" (Gould).	282
309	4 Draconis - -	12 25 44	+2·7	+69 55·3	−19·9	5·3	Reddish orange. "Pale orange" (Davis).	—
310	23649 Lal. Virginis -	12 34 21	+3·1	− 5 33·1	−19·8	6½	"Reddish" (Chambers, Wickham).	—
311*	4287 B.A.C. Canum Venaticorum.	12 40 25	+2·8	+45 59·2	−19·8	5½	Red. "Good orange" (Brodie). "Deep orange" (Backhouse). "Decided red" (Davis). Probably var.	290
312	− Crucis - -	12 41 34	+3·5	−59 8·9	−19·8	8½	"Most intense blood red" (J. Herschel).	291
313	κ Crucis - - -	12 47 50	+3·5	−59 49·9	−19·6	7	In neb. h 3435; central and largest red star."	295
314	ψ Virginis - -	12 49 9	+3·1	− 8 59·7	−19·6	5·0	Reddish orange. "Decided orange" (Davis). "Red" (*Uran. Arg.*). "Orange" (Whitley).	—
315	− Draconis - -	12 52 30	+2·4	+66 32·1	−19·5	7	Pale crimson - -	298
316	24148 Lal. Comæ Berenicis.	12 53 10	+3·0	+18 18·5	−19·5	8	Red - - - -	299
317	36 Comæ Berenicis -	12 53 59	+2·9	+17 56·8	−19·5	5·0	Reddish yellow. "Pale orange" (Davis). "Perhaps var."	300
318	5460 Lac. Centauri -	13 10 43	+3·4	−44 10·5	−19·1	7	"Red" (Stone).	—
319	5460 Lac. Centauri -	13 10 43	+3·4	−44 10·5	−19·1	7	"Red" (Stone).	—
320	γ Hydræ - -	13 13 28	+3·2	−22 38·6	−19·0	3·4	"Pale orange" (Chambers, Davis). "Red" (Brodie). "Perhaps var."	303
321	i Virginis - -	13 21 27	+3·2	−12 41·2	−18·8	5·5	Reddish. "Yellowish red" (Brodie). "Decided orange" (Davis). "Orange" (Whitley).	306
322	l^2 (74) Virginis -	13 26 45	+3·1	− 5 44·4	−18·6	4·9	Orange. "Reddish" (Davis). "Red" (*Uran. Arg.*)	309
323	W.B. XIII. 596 Comæ Berenicis.	13 32 16	+2·8	+25 10·2	−18·4	6½	Orange - - -	311
324	25213 Lal. Virginis -	13 34 35	+3·2	−15 56·3	−18·3	6½	Reddish. "Red" (Robinson).	—

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		h m s	s	° ′	″			
325	83 Ursæ Majoris -	13 36 58	+2·3	+55 10·4	−18·3	4·8	Golden. "Decided orange" (Davis). "? Var."	312
326	7561 Stone Hydræ -	13 43 22	+3·4	−27 52·0	−18·6	6½	Very red. Double. 413 β. Mags. 7, 10 Pos. 109°, dist. 77″.	313
327	υ Boötis - -	13 44 39	+2·9	+16 17·6	−18·0	4·1	Orange (Chambers, Whitley.) "Pale orange (Davis). "Probably var."	314
328	25462 Lal. Virginis -	13 44 44	+3·3	−20 22·3	−18·0	7	"Reddish" (Chambers, Robinson).	—
329	3105 Rad. Canum Venat.	13 49 3	+2·5	+40 49·9	−17·8	7	Orange - -	316
330	π Hydræ - -	14 0 40	+3·4	−26 12·0	−17·3	3·5	Deep orange - -	318
331	θ Centauri - -	14 0 47	+3·6	−35 52·7	−17·3	1·7	"Pale orange?" (Tupman).	—
332	— Centauri - -	14 2 1	+4·2	−59 14·9	−17·2	8	"Double; both stars brick red" (J. Herschel).	319
333	13 Boötis - -	14 4 32	+2·2	+49 55·8	−17·1	5·5	Orange. "Decided orange" (Davis).	320
334	4700 B.A.C. Virginis -	14 5 22	+3·3	−15 49·8	−17·1	5·2	Good orange. "Decided orange" (Davis).	321
335	κ Virginis - -	14 7 34	+3·2	− 9 48·5	−16·9	4·3	Orange. "Decided orange" (Davis). "Orange red" (Robinson). "Orange yellow" (Whitley).	322
336	4 Ursæ Majoris -	14 9 14	−0·3	+78 1·0	−16·9	4·9	Orange. "Decided orange" (Davis).	324
337	R Centauri - -	14 9 22	+4·3	−59 26·8	−16·9	Var. 6–10	"Ruby or high orange" (J. Herschel).	323
338	4732 B.A.C. Ursæ Minoris.	14 10 11	+1·1	+69 54·1	−16·9	5·3	"Pale orange" (Chambers, Davis).	325
339**	α Boötis - -	14 11 6	+2·8	+19 42·2	−16·8	0·0	Golden yellow. "Pale orange" (Davis). "Deep yellow" (Whitley).	326
340	Arg.+30 : 2513 Boötis	14 17 47	+2·6	+29 50·4	−16·6	6½	Reddish.	
341	4775 B.A.C. Boötis -	14 19 11	+2·9	+ 8 32·5	−16·5	7	Deep orange. "? Colour var."	327
342*	Arg.+26 : 2563 Boötis	14 19 41	+2·7	+26 9·5	−16·5	8	Ruby red. "? Var" -	328
343	106 Virginis - -	14 23 25	+3·2	− 6 27·0	+16·3	6	Red.	—
344*	ρ Boötis - -	14 27 31	+2·6	+30 48·6	−16·1	3·6	Orange. "Pale orange" (Davis). "Deep orange yellow" (Whitley).	330
345	5 Ursæ Minoris -	14 27 43	−0·1	+76 8·4	−16·0	4·3	Deep yellow (Chambers, Whitley). "Decided orange" (Davis).	332
346	α^2 Centauri - -	14 32 49	+4·5	−60 25·2	−15·7	1·0	"Red." "Rich yellow."	335

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
347	Arg.+33 : 2482 Boötis	14 35 4	+2·5	+32 57·9	−15·6	8½	Decided red.	—
348	34 Boötis - -	14 38 1	+2·6	+26 57·2	−15·5	4·9	Orange. "Decided orange or reddish" (Davis). "Orange yellow" (Whitley).	337
349**	ε Boötis - -	14 40 37	+2·6	+27 29·7	−15·2	2·6	Golden yellow. "Pale orange" (Davis). "Yellowish orange" (Backhouse). "Yellow" (Whitley).	339
350	σ Libræ - -	14 44 25	+3·5	−27 32·5	−15·0	5	Red - - -	340
351	β Ursæ Minoris -	14 50 59	−0·2	+74 33·8	−14·7	2·1	Deep golden yellow. "Decided orange" (Davis). "Yellow" (Whitley). "? Var."	341
352	27215 Lal. Libræ -	14 52 19	+3·3	−12 2·6	−14·6	7½	Red.	—
353	4949 B.A.C. Ursæ Minoris.	14 55 59	−0·9	+66 19·8	−14·3	4¾	"Orange" (Chambers, Backhouse). "Reddish" (Davis).	342
354	20 Libræ - -	14 58 12	+3·5	−24 53·3	−14·3	3·2	Orange red. "Reddish" (Bellamy). "Red" (Robinson). "Not red" (*Washburn Obs.*) "White" (Whitley).	343
355	ν^1 Libræ - -	15 1 3	+3·3	−15 52·8	−14·1	5·4	Reddish orange. "Decided orange" (Davis). "Orange" (Whitley).	344
356	4984 B.A.C. Libræ -	15 4 1	+3·5	−23 36·2	−14·0	7½	Red.	—
357	4976 B.A.C. Triang. Aust.	15 4 40	+5·6	−69 42·2	−14·1	6	"Almost scarlet" (J. Herschel.) "Red" (Stone).	345
358	δ Lupi - -	15 11 45	+3·6	−29 46·8	−13·5	3·7	Red - - -	346
359	ϕ^1 Lupi - -	15 15 28	+3·8	−35 53·9	−13·2	3·6	"Very red" (Gould). "Reddish yellow" (Williams).	—
360	— Apodis - -	15 16 8	+7·0	−75 34·5	−13·2	7	"Very high red" (J. Herschel).	347
361	11 Ursæ Minoris -	15 17 11	−0·08	72 11·2	−13·0	5·1	Reddish. "Decided orange" (Davis).	351
362	ε Trianguli Australis	15 27 33	+5·4	−65 58·6	−12·5	4·6	"Orange" (Tupman).	—
362	39 Libræ - -	15 30 56	+3·6	−27 48·2	−12·1	3·9	Decided red. "Not red" (*Washburn Obs*).	355
363	Arg.+24 : 2901 Coronæ Borealis.	15 33 58	+2·6	+24 51·0	−11·9	7	Orange. "Orange ruby" (Webb).	—
364*	θ Ursæ Minoris -	15 34 22	−1·9	+77 40·9	−11·8	5·3	Orange. "Decided orange" (Davis).	357
365	κ Libræ - -	15 36 11	+3·4	−19 21·3	−11·7	5·0	Reddish orange. "Decided orange" (Davis). "Orange yellow" (Whitley).	—
366	κ Serpentis - -	15 44 14	+2·7	+18 27·0	−11·3	4·2	Orange "Decided orange" (Davis). "Orange yellow" (Whitley).	358

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
367	—Coronæ Borealis -	15 45 56	+2·1	+39 52·3	−11·1	8½	Good red. "Fine ruby" (J. Herschel). Var.	361
368*	ρ Serpentis - -	15 46 51	+2·6	+21 16·8	−11·1	4·8	Pale orange. "Decided orange, but less so than κ" (Davis). "Deep yellow" (Whitley).	363
369	θ Libræ - -	15 48 7	+3·4	−16 26·2	−10·9	4·3	"Pale orange" (Chambers, Davis). "Yellow" (Whitley).	365
370	28997 Lal. Libræ -	15 51 25	+3·4	−15 44·5	−10·7	6¾	Red. "Reddish" (Robinson).	—
371	Arg. +47: 2291 Coronæ Borealis.	15 59 43	+1·8	+47 30·6	−10·1	7	Reddish orange -	367
372	6661 Lac. Normæ -	16 0 28	+4·6	−52 48·6	−10·1	6¾	"Red" (Stone).	—
373	5347 B.A.C. Scorpii -	16 2 1	+3·6	−26 3·5	− 9·9	5¾	Good red.	—
374	W.B. XV., 1569 Herculis.	16 3 2	+2·6	+22 5·5	− 9·9	—	Reddish yellow. "Straw colour" (*Washburn Obs.*). "Pale yellowish red" (Brodie).	369
375	47 Serpentis - -	16 3 39	+2·9	+ 8 48·6	− 9·7	5¾	Decidedly reddish." "Pale orange" (Davis).	370
376	Arg. + 9: 3153 Serpentis.	16 3 48	+2·9	+ 8 53·6	− 9·7	7½	Orange - - -	371
377**	δ Ophiuchi - -	16 9 6	+3·1	− 3 26·2	− 9·4	2·8	Reddish orange. "Decided orange" (Davis). "Very red (Wickham). "Orange red" (Robinson). "Deep orange yellow" (Whitley).	373
378	—Normæ - -	16 10 49	+4·3	−45 33·3	− 9·2	8½	"Ruby red" (J. Herschel).	374
379	ν^1 Coronæ Borealis -	16 18 35	+2·2	+34 1·1	− 8·6	5·1	Orange. "Decided orange" (Davis). "Deep orange yellow" (Whitley).	376
380**	ν^2 Coronæ Borealis -	16 18 43	+2·2	+33 55·2	− 8·6	5·0	Orange. "Decided orange" (Davis). "Deep orange yellow" (Whitley). This and the preceding star are almost identical in colour and size.	377
381	V Ophiuchi - -	16 21 10	+3·3	−12 12·0	− 8·5	Var 8–9	"Red or crimson" (Brodie). Dunér's var. "Very red" (Robinson).	379
382	α Scorpii - -	16 23 16	+3·7	−26 12·6	− 8·2	1·1	Fiery red - -	381
383	β Herculis - -	16 25 55	+2·6	+21 42·5	− 8·0	2·8	Golden. "Pale orange" (Davis). "Yellow" (Whitley). There is a red star ½° *nf.* mag. 7 ?	383
384	30129 Lal. Herculis -	16 27 22	+2·2	+35 26·3	− 7·9	6½	Reddish orange.	—

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		h m s	s	° ′	″			
385	111 P. XVI. Scorpii	16 29 47	+3·9	−35 3·0	+ 7·7	4·4	"Red"	384
386	— Ophiuchi	16 33 39	+3·3	−11 7·5	− 7·4	8	Red.	—
387	— Scorpii	16 34 12	+3·8	−32 11·0	− 7·4	8	"Deep red, like a drop of blood" (J. Herschel).	385
388	α Trianguli Australis	16 38 4	+6·3	−68 50·6	− 7·0	2·2	"Orange; yellow" (Tupman).	—
389	Arg.+32 : 2772 Herculis.	16 39 33	+2·1	+36 42·2	− 6·9	8	Reddish. In the field with clus. 13 M.	386
390	η Aræ	16 41 8	+5·4	−58 51·7	− 6·9	3·8	"Orange" (Tupman).	—
391	ε Scorpii	16 43 41	+3·9	−34 6·7	− 6·5	2·2	"Orange; yellow" (Tupman).	—
392	W.B. XVI. 1347 Herculis.	16 44 8	+1·9	+42 25·7	− 6·5	7	Pale orange	389
393	ζ^2 Scorpii	16 47 32	+4·2	−42 11·3	− 6·3	3·6	"Deep orange-yellow" (Williams).	—
394	ζ Aræ	16 50 20	+4·9	−55 49·9	− 6·0	3·2	"Bright orange" (Tupman).	—
395	30 Ophiuchi	16 55 47	+3·2	− 4 4·3	− 5·5	5·0	Reddish orange. "Decided orange" (Davis). "Probably var."	399
396**	α^1 Herculis	17 10 5	+2·7	+14 30·2	− 4·3	3·2	"Deep orange" (Chambers, Backhouse). "Decided orange" (Davis). "Orange - yellow" (Whitley). "Reddish; companion blue" (Robinson). "Var."	402
397**	4490 Rad. (1890) Ophiuchi.	17 10 33	+3·4	−15 6·7	− 4·3	7½	Fiery red.	—
398	π Herculis	17 11 33	+2·1	+36 55·3	− 4·2	3·4	Fiery orange. "Decided orange" (Davis.) "Deep yellow" (Whitley). "? Var."	404
399	—Ophiuchi	17 14 43	+3·0	+ 2 15·7	− 4·0	7	Red	407
400	Arg.+17 : 3225 Herculis.	17 16 19	+2·6	+17 8·4	− 3·9	8	Red.	—
401	β Aræ	17 16 59	+5·0	−55 26·1	− 3·7	2·8	"Deep bright orange" (Tupman).	—
402	43 Ophiuchi	17 17 4	+3·7	−28 2·7	− 3·7	5½	Reddish	408
403	δ Aræ	17 22 4	+5·4	−60 36·0	− 3·4	3·7	"Pale orange" (Tupman).	—
403A	—Scorpii	17 23 31	+4·0	−35 33·8	− 3·3	9	"Very deep red" (J. Herschel).	409
404**	— Ophiuchi	17 23 48	+3·5	−19 23·5	− 3·2	8	Very decided red. "Ruby" (J. Herschel). "Deep red, nearly crimson" (Brodie).	410
405	— Scorpii	17 33 24	+4·2	−41 34·5	− 2·5	8	"Ruby" (J. Herschel).	414

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		h m s	s	° ′ ″	″			
406	— Aræ - - -	17 34 40	+5·2	−57 40·4	− 2·4	8	"Scarlet or high orange" (J. Herschel).	415
407	μ Herculis - -	17 42 33	+2·3	+27 46·7	− 2·3	3·5	"Orange red" (Robinson).	—
408	76 Espin Herculis -	17 43 19	+2·1	+36 7·2	− 1·7	6½	Reddish orange.	—
409	Arg. + 36: 2942 Herculis.	17 44 24	+2·0	+36 35·4	− 1·3	6½	Reddish orange.	—
410	W.B. XVII. 877 Ophiuchi.	17 46 4	+2·8	+11 58·6	− 1·3	6¾	Pale orange.	—
411	Arg. + 1: 3524 Ophiuchi.	17 46 57	+3·0	+ 1 7·9	− 1·2	7	Red. ? 886 Weisse.	—
412	Arg. + 1: 3528 Ophiuchi.	17 47 27	+3·0	+ 1 20·2	− 1·0	6½	Fiery red. In a fine field.	—
413	— Ophiuchi - -	17 53 2	+3·0	+ 2 43·8	− 0·7	7	Reddish. "? Var" -	422
414**	γ Draconis - -	17 54 17	+1·4	+51 30·0	− 0·5	2·4	Fiery orange. "Decided orange" (Davis).	423
415	γ² Sagittarii - -	17 59 23	+3·8	−30 25·4	− 0·1	3·0	Reddish orange. "? Var."	425
416	— Sagittarii - -	18 3 58	+3·4	−15 18·1	+ 0·2	8	Red. "? Var." - -	427
417	7634 Lac. Sagittarii -	18 8 40	+3·8	−29 51·1	+ 0·6	7½	"Reddish" (*Washburn Obs.*).	—
418	— Sagittarii - -	18 9 11	+3·5	−18 56·8	+ 0·8	8	Fiery red. ? Mag. ? Var.	—
419	33627 Lal. Sagittarii -	18 12 30	+3·5	−18 30·6	+ 1·0	8	Reddish.	—
420	Arg. + 17: 3520 Herculis.	18 13 21	+2·6	+17 55·3	+ 1·2	7	Red.	—
421	Arg. + 23: 3299 Herculis.	18 13 57	+2·5	+23 14·5	+ 1·2	7	Orange - - -	433
422	δ Sagittarii - -	18 14 35	+3·8	−29 52·2	+ 1·3	2·8	Orange red - -	434
423	21 Sagittarii - -	18 19 23	+3·6	−20 35·7	+ 1·6	4·9	Red. "Decided orange" (Davis).	439
424	109 Herculis - -	18 19 26	+2·5	+21 43·5	+ 1·7	3·9	Golden yellow. "Decided orange or reddish" (Davis).	440
425	λ Sagittarii - -	18 21 48	+3·7	−25 28·6	− 1·9	3·1	Orange - - -	441
426**	6306 B.A.C. Sagittarii	18 27 1	+3·4	−14 56·3	− 2·3	6½	Fiery red. "Reddish" (Bellamy). "Golden yellow" (Brodie). "Reddish" (Davis).	446
427**	Arg. + 36: 3168 Lyræ	18 28 53	+2·1	+36 54·2	+ 2·5	8	Decided crimson. ? Var.	448
428	1 Aquilæ - - -	18 29 45	+3·3	− 8 18·8	+ 2·6	4	Orange. "Decided orange" (Davis).	449
429	Arg. + 38: 3219 Lyræ	18 30 46	+2·0	+38 21·7	+ 2·6	7	Red.	—
430	6343 B.A.C. Herculis	18 31 21	+2·5	+23 31·5	+ 2·6	5¾	Orange. "Decided orange" (Davis).	452
431	34746 Lal. Aquilæ -	18 39 16	+3·2	− 6 38·2	+ 3·4	7	Reddish - - -	457

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		h m s	s	° ″	″			
432	Arg.+36: 3243 Lyræ	18 39 23	+2·1	+36 52·0	+ 3·4	8	Fiery red. "No really red star here" (*Washburn Obs.*) ? Var.	458
433	Arg.+39: 3505 Lyræ	18 39 57	+2·0	+39 12·1	+ 3·4	7	Slightly red. Has a small companion. ? Colour var.	459
434	Arg.+18: 3817 Herculis.	18 42 18	+2·6	+18 35·7	+ 3·6	7	Reddish - - -	468
435**	— Clyræi Sobieskii -	18 44 30	+3·3	− 8 1·2	+ 3·7	8	Rich fiery red. "Orange" (Brodie). "? Var."	464
436*	ν^1 Sagittarii - -	18 48 8	+3·6	−22 52·1	+ 4·1	5·2	Red - - - -	466
437	ν^2 Sagittarii - -	18 49 4	+3·6	−22 47·8	+ 4·2	5½	Pale orange - -	468
438	δ^2 Lyræ - - -	18 51 0	+2·1	+36 46·2	+ 4·4	4·5	Fiery orange. "Decided orange or reddish" (Davis). "Orange" (Whitley). Good field.	470
439	W.B. XVIII. 1528 Herculis.	18 51 41	+2·6	+17 59·1	+ 4·5	5¾	Pale orange. "Decided orange" (Davis).	472
440	9 Aquilæ - -	18 51 42	+3·2	− 5 58·6	+ 4·4	5	Orange. "Pale orange" (Davis). "Red" (*Uran Arg.*).	—
441*	ξ^2 Sagittarii - -	18 51 45	+3·6	−21 14·3	+ 4·5	3·5	Orange - - -	471
442	Arg.+36: 3339 Lyræ	18 53 37	+2·1	+36 20·0	+ 4·6	7	Orange.	—
443	Arg.+38: 3362 Lyræ	18 53 43	+2·0	+38 39·9	+ 4·6	7½	Pale orange - -	476
444*	— Aquilæ - -	18 53 56	+2·7	+14 12·9	+ 4·6	9	Deep red. ? Mag. Probably var. G.F.C.	475
445	λ Lyræ - -	18 56 13	+2·3	+32 0·3	+ 4·7	5·1	Orange. "Decided orange" (Davis). "? Var."	479
446	12 Aquilæ - -	18 56 20	+3·2	− 5 52·8	+ 4·8	4·0	Orange. "Pale orange" (Davis). "? Var."	478
447	35562 Lal. Aquilæ -	18 57 33	+2·9	+ 8 15·6	+ 4·9	6½	Orange. ? Var. - -	480
448	35624 Lal. Aquilæ -	18 58 33	+2·9	+ 8 8·8	+ 5·0	8	Good orange. Var. both in colour and brightness.	482
449**	35611 Lal. Aquilæ -	18 59 3	+3·2	− 5 50·0	+ 5·0	7½	Very fine fiery red. "Deep red" (Wickham). "Crimson" (Bellamy). "? Var."	483
450	τ Sagittarii - -	19 0 41	+3·7	−27 49·0	+ 5·2	3·5	Reddish orange -	485
451	35928 Lal. Vulpeculæ	19 4 37	+2·5	+24 1·2	+ 5·5	7	Red - - -	487
452	Arg.+18: 4011 Sagittæ	19 11 8	+2·6	+18 20·9	+ 6·0	7	Orange - - -	490
453	δ Draconis - -	19 12 31	+0·01	+67 29·1	+ 6·0	3·2	"Decided orange" (Davis).	491
454	— Lyræ - -	19 15 3	+2·4	+27 4·6	+ 6·4	7	Red. "? Var" -	492
455	Arg.+22: 3660 Vulpeculæ.	19 15 16	+2·5	+22 23·1	+ 6·4	8	Reddish - -	493

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		h m s	s	° ′	″			
456	4 Vulpeculæ -	19 21 5	+2·6	+19 36·1	+ 6·8	5·2	Orange. "Decided orange." "Pale red" (Davis). Fine field. Two other orange stars near.	—
457*	Arg.+49: 2999 Cygni	19 21 55	+1·6	+50 2·2	+ 6·9	7	Fiery red.	—
458	Arg.+1: 4004 Aquilæ	19 22 48	+3·0	+ 1 58·4	+ 7·0	8	Reddish. "? Var" -	498
459**	6702 B.A.C. Draconis	19 25 8	−2·0	+76 21·6	+ 7·0	6½	Strong fiery red. "? Var."	502
460	Arg.+2: 3904 Aquilæ	19 25 10	+3·0	+ 2 42·8	+ 7·0	6½	Reddish orange.	499
461	36 (ε) Aquilæ -	19 25 24	+3·1	− 2 59·9	+ 7·2	5·2	Reddish orange. "Light orange" (Brodie). "Decided orange" (Davis).	500
462	Arg.+45: 2906 Cygni	19 25 50	+1·8	+45 50·4	+ 7·2	8	Pale crimson. "Very red; ? Var" (Espin).	—
463	Arg.+1: 4021 Aquilæ	19 26 0	+3·0	+ 1 48·6	+ 7·3	8	Orange - -	501
464**	β Cygni - -	19 26 41	+2·4	+27 45·0	+ 7·4	3·1	Yellow, with a blue companion, mag. 7, dis. 34″. "Orange" (Backhouse). "Deep yellow" (Whitley). "Decided orange" (Davis). "? Var."	503
465	Arg.+4: 4152 Aquilæ	19 28 12	+3·0	+ 4 49·0	+ 7·4	7	Reddish orange -	504
466	36981 Lal. Sagittarii	19 28 34	+3·4	−16 35·5	+ 7·4	7½	Crimson. "Red; deeper at times" (Bellamy). ? Var. in colour.	505
467	Arg.+5: 4190 Aquilæ	19 28 57	+2·9	+ 5 14·8	+ 7·6	7	Orange - -	506
468	Arg.+32: 3522 Cygni	19 37 7	+2·3	+32 23·2	+ 8·2	8	Red - - -	509
469	37504 Lal. Aquilæ -	19 39 35	+3·0	+ 4 44·3	+ 8·3	8	Reddish. "? Var." -	510
470	Arg.+12: 4060 Aquilæ	19 39 57	+2·8	+12 59·4	+ 8·3	7	Reddish. Most southerly of three stars in a row.	511
471*	Arg.+40: 3866 Cygni	19 40 36	+2·0	+40 28·0	+ 8·5	6	Fiery red - -	—
472	γ Aquilæ - -	19 41 30	+2·8	+10 22·2	+ 8·6	2·8	Brilliant orange. "Reddish yellow" (Robinson). "Decided orange" (Davis). "Deep yellow" (Whitley).	512
473	Arg.+22: 3812 Vulpeculæ.	19 43 53	+2·6	+22 31·2	+ 8·8	8	Red - - -	515
474	χ Cygni - -	19 46 44	+2·2	+32 39·7	+ 9·0	Var. 4-0	Fiery red when approaching maximum. "Orange" (Davis). "Yellowish white" (Whitley).	518

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		h m s	s	° ′	″			
475	19 Cygni	19 47 1	+2·1	+38 27·8	+ 9·0	5·5	Full orange. "Pale red" (Davis). "Deep orange" (Backhouse).	519
476	Arg.+43: 3425 Cygni	19 53 57	+1·9	+43 59·3	+ 9·5	8	Fiery red	521
477	13 Sagittæ	19 55 31	+2·7	+17 14·3	+ 9·6	7½	Orange. There is a red star of mag. 7½, *n.f.*	—
478	62 (*c*) Sagittarii	19 56 30	+3·7	−27 59·3	+ 9·7	4·7	Reddish orange	522
479	38428 Lal. Cygni	20 0 3	+2·2	+38 2·8	+10·0	8	Reddish. ? Var.	—
480	— Sagittæ	20 0 41	+2·6	+20 22·3	+10·0	8½	"Blood red; not very red; red at times" (Robinson). "Very red" (Espin). "? Var. in colour" (Robinson).	527
481	Ö—Arg. (2) 20234 Sagittarii.	20 0 48	+3·7	−27 30·6	+10·0	7	Deep red. "Ruby" (J. Herschel). ? Mag. Gould made it 8, more than once.	526
481A	—Pavonis	20 2 29	+5·1	−60 13·5	+10·1	8½	"Very red" (J. Herschel).	528
482	Arg.+16: 4153 Sagittæ.	20 3 35	+2·7	+16 23·1	+10·2	6½	Orange	530
483	66 Aquilæ	20 8 4	+3·1	+ 1 18·5	+10·6	5¾	Orange. "Decided orange" (Davis).	538
484*	Arg.+38: 3957 Cygni	20 9 46	+2·2	+38 25·5	+10·9	8	Decided red	541
485	o^1 (30) Cygni	20 10 9	+1·9	+46 30·8	+10·8	3·8	Fine golden yellow, with a blue companion. "Pale red" (Davis). "Orange yellow" (Whitley).	543
486*	Ö-Arg. (2) 20363 Capricorni.	20 11 14	+3·5	−21 36·5	+10·8	7½	Decided red. "Perhaps the finest of my ruby stars" (J. Herschel). "Deep ruby; fine colour" (Brodie). "Bright ruby" (Bellamy).	545
487	23 Vulpeculæ	20 11 37	+2·5	+27 30·4	+10·8	4·8	Full orange. "Decided orange" (Davis).	546
488	α^1 Capricorni	20 12 6	+3·3	−12 49·0	+10·9	4·5	Golden yellow. "Pale orange" (Davis). "Orange yellow" (Whitley).	547
489	32 Cygni	20 12 28	+1·9	+47 24·4	+10·9	4·1	Pale orange. "Reddish" (Davis). "Orange" (Whitley).	549
490	α^2 Capricorni	20 12 30	+3·3	−12 51·3	+10·9	3·8	Golden yellow. "Pale orange" (Davis). "Orange yellow" (Whitley).	548
491	6986 B.A.C. Cygni	20 13 21	+2·1	+40 3·1	+10·9	5·5	Reddish orange. "Pale red" (Davis).	551
492	σ Capricorni	20 14 2	+3·5	−19 25·8	+11·0	5·6	Double: A, pale orange; B, colourless or ruddy. Dist. 50″. "Decided orange" (Davis).	550

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		h m s	s	° ′	″			
493	U Cygni - -	20 16 30	+1·9	+47 34·7	+11·2	Var. 7–11	Very red. "Remarkable ruby." Var. In striking contrast with blue star near.	553
494	7027 B.A.C. Cygni -	20 19 12	+2·1	+40 42·4	+11·4	6	Reddish. "Pale red" (Davis).	555
495	— Aquilæ - -	20 19 42	+3·0	+ 0 13·7	+11·4	10	Reddish. ? Var. 8–10. Should be watched.	556
496	39 Cygni - -	20 19 52	+2·4	+31 52·0	+11·4	4·6	Orange. "Decided orange" (Davis).	557
497	39304 Lal. Delphini -	20 20 55	+2·9	+ 9 43·8	+11·5	7	Orange. "Probably var."	558
498	8451 Lac. Capricorni	20 21 50	+3·7	−28 35·5	+11·6	8	Decided red. "Fine ruby" (J. Herschel).	559
499	ω^1 Cygni - -	20 23 58	+1·8	+49 3·2	+11·8	5·6	Yellow. "Reddish" (Davis).	—
500*	Arg.+15: 4172 Delphini.	20 24 34	+2·8	+15 55·9	+11·8	8½	Good red. There is a blue star of mag. 8 to the S.	—
501	Arg+39: 4208 Cygni	20 25 13	+2·2	+39 38·8	+11·8	9	Fiery red. "Colour very fine" (Espin).	—
502*	ω^3 Cygni - -	20 28 15	+1·8	+48 52·9	+11·9	5·6	Deep golden yellow. "Pale orange" (Davis). "Orange" (Whitley).	562
503	47 Cygni - -	20 30 1	+2·3	+34 54·5	+12·1	4·8	Orange. "Reddish" (Davis).	563
504	70 Aquilæ - -	20 31 31	+3·1	− 2 53·8	+12·3	5·3	Golden yellow. "Reddish" (Davis).	564
505	Arg.+17: 4370 Delphini.	20 33 21	+2·7	+17 54·8	+12·4	7	Full orange - -	566
506	Arg.+17: 4401 Delphini.	20 40 53	+2·7	+17 43·6	+12·9	7	Reddish. "Probably var."	569
507	Arg.+45: 3271 Cygni	20 43 28	+2·0	+45 41·1	+13·1	8½	Pale ruby.	—
508	Arg.+50: 3209 Cygni	20 46 26	+1·8	+50 24·8	+13·3	7½	Red.	—
509	Arg.+49: 3386 Cygni	20 47 38	+1·8	+49 45·2	+13·3	7	Deep orange.	—
510	Arg.+32: 3980 Cygni	20 50 14	+2·4	+33 3·4	+13·4	5¾	Orange. "Decided orange" (Davis).	572
511	32 Vulpeculæ -	20 50 18	+2·6	+27 41·6	+13·4	5	"Orange red" (Robinson).	—
512	1294 Bess. Delphini -	20 52 32	+2·8	+15 52·0	+13·6	8	Pale orange. "Probably var. both in mag. and colour."	573
513*	Arg.+45: 3349 Cygni	20 54 32	+2·1	+46 5·0	+13·8	8	Fiery red.	—
514	ζ Equulei - -	20 59 36	+3·0	+ 5 6·2	+14·1	5¾	Red. "Decided orange or reddish" (Davis).	—
515	A Capricorni -	21 1 16	+3·5	−25 24·3	+14·1	4·6	Deep orange - -	575
516	ξ Cygni - -	21 1 17	+2·2	+43 31·6	+14·2	3·7	Deep golden yellow. "Decided orange or reddish" (Davis). "Deep orange yellow" (Whitley).	576

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		h m s	s	° ′	″			
517	Arg.−17: 6181 Capricorni.	21 1 41	+3·4	−16 49·5	+14·3	8½	Red.	←
518	61 P. XXI. Cephei -	21 10 13	+1·5	+59 41·0	+14·7	7½	Remarkable fiery red. "? Var."	579
519	8745 Lac. Indi -	21 15 14	+5·5	−70 9·6	+14·9	6	"Red inclining to orange" (J. Herschel).	580
520	Arg.+49: 3499 Cygni	21 15 21	+2·0	+49 38·8	+15·1	7	Fiery red.	—
521	33 Capricorni -	21 18 29	+3·4	−21 16·6	+15·1	5½	Pale orange. "Red" (Gore). "Decided orange or reddish" (Davis).	—
522*	− Cygni - -	21 18 39	+2·3	+41 58·1	+15·2	9	Deep red - -	582
523	Arg.+40: 4502 Cygni	21 19 27	+3·4	+40 31·6	+15·2	7½	Red.	—
524	2 Pegasi - -	21 25 25	+2·7	+23 12·0	+15·6	4·3	Bright orange. "Decided orange."	583
525	Arg.+45: 3584 Cygni	21 29 32	+2·2	+45 24·6	+15·8	7	Reddish orange -	585
526	Arg.+44: 3877 Cygni	21 32 16	+2·3	+44 55·7	+16·0	7	Reddish orange -	587
527	889 Bess. Cygni -	21 37 47	+2·5	+35 3·2	+16·3	7	Unmistakeable fiery red.	589
528	− Cygni - -	21 37 47	+2·4	+42 23·1	+16·3	7	Strong reddish tinge. "Schmidt's *Nova* of 1876. ? δ too little. ? Present mag.	590
529**	923 Bess. Cygni -	21 39 8	+2·5	+37 33·5	+16·3	8	Deep fiery red or pale crimson. "Good red" (Brodie).	592
530**	ε Pegasi - -	21 39 16	+2·9	+ 9 25·0	+16·4	2·4	Full orange. "Deep orange yellow" (Whitley). "Decided orange" (Davis). "Reddish yellow" (Robinson). "Probably var."	591
531**	μ Cephei - -	21 40 26	+1·8	+58 19·2	+16·4	Var. 4–6	Intense reddish orange. "Light orange" (Brodie). "Decided red" (Davis).	594
532**	42431 Lal. Aquarii -	21 41 20	+3·1	− 2 40·5	+16·4	6½	Decided red. "Red" (Robinson). "? Var."	596
533	Arg.+57: 2396 Cygni	21 43 3	+1·8	+57 37·1	+16·5	8	Reddish orange.	—
534	− Cygni - -	21 51 30	+2·2	+50 1·3	+16·9	9	Pale red - -	598
535*	7658 B.A.C. Cephei -	21 53 50	+1·7	+63 8·9	+17·0	5·2	Fiery orange. "Pale red, 3 obs." (Davis).	599
536	3637 Groom. Cephei -	21 54 37	+1·5	+65 40·7	+17·1	6½	Fiery red. Blue star, mag. 6½ near, *p*.	—
537	− Pegasi - -	21 59 26	+2·7	+27 51·8	+17·3	7½	Fiery red. "Orange tinge" (Brodie). ? Var.	600
538	α Aquarii - -	22 0 38	+3·1	−0 48·4	+17·3	3·2	"Orange" (Chambers, Robinson).	—
539	18 Cephei - -	22 0 53	+1·8	+62 38·0	+17·3	5·4	Reddish orange. "Decided orange" (Davis).	601

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		h m s	s	° ′	″			
540	20 Cephei - - -	22 1 58	+1·8	+62 17·9	+17·3	5·4	Orange. "Decided orange" (Davis).	602
541	ζ Cephei - - -	22 7 23	+2·0	+57 42·5	+17·7	3·5	Pale orange. "Decided orange" (Davis).	604
542	7766 B.A.C. Cephei -	22 9 15	+1·9	+62 47·8	+17·7	6·1	Reddish orange -	606
543	7765 B.A.C. Lacertæ -	22 9 36	+2·6	+39 13·1	+17·7	4·6	Orange. "Decided orange" (Davis).	607
544	1 Lacertæ - -	22 11 36	+2·6	+37 15·1	+17·8	4·1	Orange. "Pale orange" (Davis).	608
545	43501 Lal. Pegasi -	22 12 27	+3·0	+ 4 38·6	+17·8	7¾	Dull pale red. "Tinge of red" (Brodie).	609
546	7813 B.A.C. Cephei -	22 19 20	+2·2	+55 27·4	+18·1	7	Good red - -	610
547	β Lacertæ - -	22 19 38	+2·3	+51 43·7	+18·1	4·5	Orange. "Pale orange" (Davis).	611
548	36 Pegasi - -	22 24 9	+3·0	+ 8 37·1	+18·3	6	Reddish orange. "Red" (*Uran. Arg.*).	—
549	5 Lacertæ - -	22 25 22	+2·5	+47 11·7	+18·3	4·6	Reddish orange. "Deep orange, but not reddish" (Davis).	612
550	δ Cephei - -	22 25 27	+2·2	+57 54·1	+18·3	Var 3½–4½	Orange, with blue companion in good contrast. "Pale orange" (Davis).	613
551	Arg.+56: 2793 Cephei	22 26 23	+2·3	+56 29·0	+18·4	8	Fiery red.	—
552	Arg.+57: 2562 Cephei	22 30 45	+2·3	+57 39·3	+18·5	7½	Fiery red.	—
553	Arg.+57: 2568 Cephei	22 32 39	+2·3	+57 54·6	+18·5	7½	Red. "Var. 7—8" (Espin).	—
554	Arg.+56: 2821 Cephei	22 34 42	+2·4	+56 16·7	+18·6	5½	Reddish. "Decided orange or Reddish" (Davis).	615
555	11 Lacertæ - - -	22 36 7	+2·6	+43 46·2	+18·7	4·7	Reddish orange. "Decided orange" (Davis).	616
556	β Gruis - -	22 36 41	+3·6	+47 24·5	+18·7	2·2	Reddish - - -	617
557*	τ^3 Aquarii - -	22 44 17	+3·2	−14 7·2	+18·9	4·1	Orange, "Decided orange" (Davis) ? Var.	620
558	15 Lacertæ - -	22 47 30	+2·7	+42 46·8	+19·0	5·1	Reddish orange. "Decided orange" (Davis).	622
559	267 P. XXII. Aquarii	22 54 39	+3·2	−25 41·9	+19·2	6	Reddish. "Pale red" (Brodie).	625
560**	β Pegasi - -	22 58 55	+2·9	+27 32·4	+19·3	2·6	Rich golden. "Decided orange" (Davis). "Deep yellow" (Whitley).	627
561**	55 Pegasi - - -	23 1 57	+3·0	+ 8 52·1	+19·4	4·6	Orange. "Decided orange" (Davis). "Orange yellow" (Whitley).	629
562	57 Pegasi - -	23 4 28	+3·0	+ 8 8·1	+19·4	5½	Reddish orange. "Decided orange" (Davis).	630

No.	Name of Star.	R.A., 1900.	Prec. in R.A.	Decl., 1900.	Prec. in Decl.	Mag.	Colour: Remarks.	No. in Birm. Cat., 1876.
		h m s	s	° ′	″			
563	W.B. XXIII. 48 Piscium.	23 6 8	+3·0	+ 4 27·4	+19·5	8	Orange.	—
564	Aquarii 286 - -	23 8 33	+3·1	−13 56·3	+19·5	7	Reddish. Double, A 7 : B 10, Dist. 1·4″, ? Mag.	631
565	ϕ Aquarii - -	23 9 8	+3·1	− 6 35·3	+19·5	4·2	Deep orange. "Decided orange" (Davis). "Orange" (Whitley).	632
566	ψ^1 Aquarii - -	23 10 39	+3·1	− 9 37·9	+19·5	4·5	Orange. "Pale orange" (Davis).	633
567	χ Aquarii - -	23 11 40	+3·1	− 8 16·3	+19·6	5·2	Orange. "Decided orange" (Davis).	634
568**	8 Andromedæ -	23 13 4	+2·7	+48 28·1	+19·6	4·9	Fiery red. "Decided orange or reddish" (Davis).	635
569	2557 Arg. Cassiopeiæ	23 19 47	+2·6	+61 2·3	+19·7	8¾	Reddish. In clus. h 2238.	639
570	71 Pegasi - -	23 28 27	+3·0	+21 56·8	+19·8	5·4	Deep orange. "Pale orange" (Davis).	643
571	λ Andromedæ -	23 32 40	+2·9	+45 55·0	+19·5	4·6	Orange. "Pale orange" (Davis).	644
572	77 Pegasi - -	23 38 18	+3·0	+ 9 46·3	+19·8	5·4	Deep orange. "Decided orange or even reddish" (Davis).	645
573	19 Piscium - -	23 41 15	+3·0	+ 2 55·9	+20·0	5·2	Decided red. "Deep orange" (Backhouse). "Pale red" (Davis). "Red" (Robinson). "Probably var."	648
574	4154 Groombridge Cephei.	23 47 30	+2·8	+74 59·1	+20·0	6¼	Reddish orange -	651
575	235 P. XXIII. Pegasi.	23 51 36	+3·0	+23 3·5	+20·0	6	Reddish. "Slightly red" (*Uran. Arg.*).	653
576	9659 Lac. Sculptoris -	23 51 58	+3·1	−27 10·9	+20·0	6½	Reddish - -	654
577**	ψ Pegasi - -	23 52 40	+3·0	+24 35·7	+20·0	4·6	Reddish yellow. "Decided orange" (Davis).	655
578**	R Cassiopeiæ -	23 53 19	+3·0	+50 49·9	+20·0	Var. 5–12	Very red "Decided orange or reddish" (Davis).	656
579**	6259 Rad. Cassiopeiæ	23 56 8	+3·0	+59 47·9	+20·0	8	Very fiery red. Blue star of mag. 9 near.	658
580*	30 Piscium - -	23 56 49	+3·1	− 6 34·2	+20·0	4·6	Fiery red. "Decided orange" (Davis). "Orange red" (Robinson).	—

Rejected Stars.

After the principal catalogue was completed I thought it might be desirable to preserve some record of the stars which had been rejected* from it on the ground that they were not of sufficiently decided colour to be ranked as "orange," much less as "red" stars. There was evidence to show, however, that peculiarities of eye, and perhaps also of instrument, affect the judgment of some observers with respect to certain stars, and that one man would call "orange" a star which another would write down as "yellow," or it might be, "tinged." By putting together these doubtful stars in a catalogue by themselves the door is left open for their examination by other observers in future years who may be able, perhaps, in some instances, to show that particular stars must have changed colour. As things stand at present, however, it must be taken that to the best of my judgment these stars cannot with propriety be included in a catalogue of "red" stars.

I have, therefore, treated them simply as raw material, and have made no attempt to bring their places up to a common epoch, or to verify the places or particulars of magnitude, merely giving these in the form in which they were brought under my notice by correspondents or otherwise. I may state, however, that with very few exceptions all the rejected stars visible in England have been examined by myself, and many of them have been observed by different members of the Section.

Star.	R.A.	Decl.	Epoch.	Mag.
— Cassiopeiæ	0 3 38	+63 20·4	1890	9
— Cassiopeiæ	0 9 5	+65 29·8	1890	8½
ζ Andromedæ	0 41·0	+23 37	1880	4·4
— Cassiopeiæ	0 50 59	+67 5·9	1890	8¾
2 Ursæ Minoris	0 53 39	+85 39·1	1890	5
239 Groom. Cassiopeiæ	1 0 36	−52 54·5	1890	6¼
Arg. +51: 243	1 5	+51 47	1900	8·7
2393 Lal.	1 15	+ 5 38	1900	7·7
36 Espin Persei	1 36 39	+57 53·0	1900	6
χ Eridani	1 51·1	−52 14	1875	3·6
39 Arietis	2 40·8	+28 45	1880	4·6 (Whitley).
5172 Lal. Persei	2 43 30	+57 52·6	1890	7½
ρ Persei	2 57·5	+38 22	1880	3·7 (Whitley).
— Tauri	3 36 2	+14 26·4	1890	8
6921 Lal. Eridani	3 38 28	− 9 57·3	1890	7½
Arg. +23: 519	3 40	+33 53	1900	8·5
220 P. III. Tauri	3 55 45	+ 9 41·4	1890	6]

* This expression is intended to cover the case of stars which at one time it was seriously intended to include as possessing claims to be regarded as "orange" or "red." This appendix does not embrace a large number of stars with some tinge of colour which are included in Birmingham's well-known and valuable catalogue, and Schjellerup's less known but also valuable catalogue.

Star.	R.A.	Decl.	Epoch.	Mag.
45 Espin Tauri	3 58 10	+12 12·0	1890	$7\frac{1}{2}$
47 Tauri	4 7 57	+ 8 59·1	1890	5
19 P. IV. Tauri	4 8 51	+ 9 43·8	1890	$5\frac{1}{4}$
8154 Lal. Eridani	4 15 14	− 6 30·4	1890	$6\frac{1}{4}$
2 Espin Aurigæ	4 38 38	+32 14·7	1890	$8\frac{1}{2}$
149 Espin	4 47 12	+22 35·7	1890	9
α Aurigæ	4 49·2	+32 58	1880	2·7 (Whitley).
— Orionis	4 53 14	+12 40·0	1890	$8\frac{3}{4}$
150 Espin Aurigæ	4 55 50	+38 54·8	1890	$8\frac{1}{2}$
276 P. IV. Orionis	4 56 11	+ 0 33·6	1890	$6\frac{1}{4}$
— Orionis	5 0 57	+ 0 24·2	1890	9
152 Espin Aurigæ	5 4 15	+43 34·5	1890	8
9744 Lal. Orionis	5 4 26	− 0 42·1	1890	$6\frac{1}{2}$
5 Espin Aurigæ	5 10 59	+40 20·6	1890	7 ? Identity.
51 Espin Orionis	5 12 44	− 8 21·9	1890	$8\frac{1}{2}$
— Orionis	5 18 1	− 9·25·9	1890	$8\frac{1}{2}$
ϕ Aurigæ	5 20·4	−34 24	1890	5·4 (Whitley).
6 Espin Aurigæ	5 22 39	+40 25·5	1890	$7\frac{1}{2}$
7 Espin Aurigæ	5 26 31	+41 2·3	1890	$7\frac{1}{2}$
56 Espin Aurigæ	5 40 33	+44 48·0	1890	9
τ Aurigæ	5 40·9	+39 8	1880	4·6
ν Aurigæ	5 43·2	+39 7	1880	4·2 (Whitley).
Arg. +32 : 1118 Aurigæ	5 46 6	+32 9·3	1890	$8\frac{1}{2}$
11 Espin Aurigæ	5 46 19	+40 21·8	1890	8
γ Pictoris	5 47·5	−56 12	1875	4·3
Arg. +20 : 1171 Orionis	5 49 5	+20 26·9	1890	8
14 Espin Aurigæ	6 4 56	+32 43·3	1890	6
15 Espin Aurigæ	6 6 48	+33 16·3	1890	7
5 Monocerotis	6 9 30	− 6 14·4	1890	$4\frac{1}{4}$
16 Espin Aurigæ	6 9 52	+39 53·7	1890	7
17 Espin Aurigæ	6 10 2	+40 24·8	1890	$8\frac{1}{2}$
18 Espin Aurigæ	6 10 6	+39 30·6	1890	7
20 Espin Monocerotis	6 28	− 3 0	1886	$7\frac{1}{2}$
23 Espin Geminorum	6 38 36	+24 46·5	1890	$7\frac{1}{2}$
Arg. −8 : 1650 Monocerotis	6 52 49	− 8 52·6	1890	7
o^2 Canis Majoris	6 58 26	−23 40·4	1890	3
δ Canis Majoris	7 3 55	−26 13·1	1890	2
174 Espin Monocerotis	7 30 44	− 5 31·8	1890	8
175 Espin Canis Minoris	7 30 44	+ 2 19·0	1890	$8\frac{3}{4}$
27 Espin Geminorum	7 35 43	+29 5·2	1890	8
κ Cancri	9 1·3	+11 9	1880	5·0 (Whitley).
18688 Lal. Hydræ	9 24 8	+20 16·0	1890	$6\frac{1}{2}$
υ Ursæ Majoris	9 42·5	+59 36	1880	4·0 (Whitley).
3380 B.A.C. Sextantis	9 4·8	+ 6 20	1900	6·5
29 Espin Leonis	9 51 46	+ 8 53·7	1890	7
γ Leonis	10 13 54	+20 23·8	1890	2
31 Espin Leonis	10 52 45	+20 13·4	1890	7
1917 H.P. Crateris	10 54 5	−15 45·8	1890	$6\frac{1}{4}$
60 Leonis	10 56 27	+20 46·3	1890	$4\frac{1}{2}$
α Ursæ Majoris	10 56 56	+62 20·7	1890	2
75 Leonis	11 11 37	+ 2 37·0	1890	$5\frac{1}{2}$
ν Virginis	11 39·7	+ 7 12	1880	4·2
o Virginis	12 0	+ 9 17	1900	4·3
17 Virginis	12 16 5	+ 5 55·2	1890	7

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Star.	R.A.	Decl.	Epoch.	Mag.
— Comæ Berenicis	12 23 40	+28 54·2	1890	9
β Corvi	12 28·1	−22 44	1880	2·8 (Whitley).
23736 Lal. Virginis	12 38 3	− 0 50·1	1890	8½
δ Virginis	12 50 3	+ 3 59·7	1890	3¾
1944 Groom. Draconis	12 52 45	+67 50·2	1890	6½
9 Draconis	12 55 57	+67 11·5	1890	5½
Arg. + 5 : 2708	12 58	+ 5 43	—	8, var.
σ Virginis	13 12 3	+ 0 3·0	1890	5
61 Virginis	13 12 40	−17 41·8	1890	4¾
24769 Lal. Virginis	13 16 14	−13 50·5	1890	7
4479 B.A.C. Canum Venat.	13 18 54	+37 36·3	1890	6½
o Virginis	13 38	+ 4 3	1900	6·5
i (10) Draconis	13 48 11	+65 15·9	1890	4¾
95 Virginis	14 0 53	− 8 47·3	1890	5¾
— Virginis	14 10 57	−16 0·8	1890	8¾
— Virginis	14 23 55	− 5 29·5	1890	8
4825 B.A.C. Böotis	14 30 8	+37 6·5	1890	6½
— Libræ	14 34 31	−14 49·6	1890	8
Arg. + 32 : 2504 Böotis	14 36 33	+32 1·5	1890	8
— Böotis	15 5	+52 12	1885?	8?
6 Serpentis	15 15 24	+ 1 7·0	1890	5½
— Libræ	15 16 10	−28 47·2	1890	8½
S Serpentis	15 17	+ 4 40	1900	8·3 var.
ι Draconis	15 22 29	+59 21·1	1890	3½
ζ¹ Libræ	15 23	−16 22	1900	6·2
11 Serpentis	15 27 18	+ 0 48·8	1890	6
μ Coronæ Bor.	15 31·2	+39 22	1890	5·4 (Whitley).
r⁴ Serpentis	15 31 22	+15 28·0	1890	6½
α Serpentis	15 39	+ 6 44	1900	2·7
— Libræ	15 41 34	−19 47	1880?	8
ω Serpentis	15 44 44	+ 2 32·0	1890	5
κ Coronæ Borealis	15 46·7	+36 2	1880	4·7 (Whitley).
T Coronæ Borealis	15 55	+26 12	1900	9·5 var.
— Scorpii	16 3 3	−26 9·6	1890	7½?
29441 Lal. Serpentis	16 4 5	+ 1 6·8	1890	7
ε Ophiuchi	16 12 29	− 4 25·3	1890	3½
30593 Lal. Ophiuchi	16 43 42	+ 0 7·0	1890	9
30790 Lal. Ophiuchi	16 50 31	+ 1 35·9	1890	8
κ Ophiuchi	16 52 27	+ 9 32·8	1890	3½
61 Herculis	16 59 36	+34 33·6	1890	7
70 Espin Herculis	16 59 6	+35 33·8	1890	6½
μ Herculis	17 13 15	+33 13·0	1890	5
λ Herculis	17 25 17	+26 11·6	1890	4¼
β Draconis	17 27 57	+52 22·9	1890	3
5986 B.A.C. Herculis	17 35 48	+31 15·7	1890	6½
β Ophiuchi	17 38 2	+ 4 36·8	1890	3
— Serpentis	17 38 28	−18 36·4	1890	8½
— Ophiuchi	17 41 57	− 3 36·3	1890	8
Albany (A.G.) 5962	17 47	+ 1 8	1900	6·7
ξ Draconis	17 51 35	+56 53·3	1890	4
A (104) Herculis	18 7 47	+31 22·7	1890	5
Arg. + 22 : 3303 Herculis	18 8 15	+22 48·1	1890	7½
Albany (A.G.) 6154	18 9	+ 2 22	1900	7
Albany (A.G.) 6167	18 11	+ 2 21	1900	6·3
η Sagittarii	18 10 11	−36 47·8	1890	3
33933 Lal. Serpentis	18 13 49	+ 0 47·9	1890	8
33896 Lal. Herculis	18 16 57	+25 0·2	1890	7½

Star.	R.A.	Decl.	Epoch.	Mag.
— Serpentis	18 18 17	− 1 38·3	1890	7
60 Serpentis	18 23 57	− 2 3·4	1890	5½
34307 Lal. Aquilæ	18 27 16	− 5 14·5	1890	7½
123 P. XVIII. Clyp. Sob.	18 30 12	− 6 49·9	1890	7
34507 Lal. Aquilæ	18 32 40	−13 52·6	1890	8
— Serpentis	18 32 42	+11 21·3	1890	8½
83 Espin Lyræ	18 33 46	+37 41·0	1890	7
Arg. + 33 : 3192 Lyræ	18 40 50	+33 4·5	1890	8
— Lyræ	18 46 40	+39 10	1885?	9 ?
32 Serpentis	18 50 6	− 6 28·8	1890	6
— Aquilæ	18 51 57	+ 0 18·5	1890	9
ϵ Aquilæ	18 54·2	+14 54	1880	4·1 (Whitley).
Arg. + 22 : 3549 Vulpeculæ	18 55 19	+22 39·7	1890	6½
o Sagittarii	18 58 5	−21 44·1	1890	4
89 Espin Lyræ	19 4 28	+38 58·7	1890	7
91 Espin Lyræ	19 13 22	+38 47·6	1890	6¾
93 Espin Sagittæ	19 16 43	+17 27·5	1890	9½
3 Cygni	19 20 54	+24 42·9	1890	6
— Vulpeculæ	19 21 30	+19 34·8	1890	6
128 P. XIX. Vulpeculæ	19 21 40	+19 40·3	1890	6¼
μ Aquilæ	19 28·2	+ 7 8	1880	4·7 (Whitley).
97 Espin Vulpeculæ	19 31 12	+23 36·3	1890	8
98 Espin Vulpeculæ	19 35 13	+17 38·4	1890	8
104 Espin Aquilæ	19 42 18	+ 9 45·9	1890	8
ξ Aquilæ	19 48·5	+ 8 9	1880	4·9 (Whitley).
— Aquilæ	19 48 46	+ 9 25	?	? (Prince).
181 Espin Cygni	19 56 30	+30 31·2	1890	9¼
Arg. + 36 : 3820 Cygni	19 57 13	+36 47·6	1890	7
19 Vulpeculæ	20 7 12	+26 29·0	1890	5¾
Arg. + 36 : 3956 Cygni	20 10 25	+36 19·6	1890	8
38988 Lal. Aquilæ	20 13 21	+ 0 15·2	1890	8¾
ν Capricorni	20 14·0	−13 8	1880	4·7 (Whitley).
115 Espin Cygni	20 17 37	+53 14·2	1890	7
116 Espin Cygni	20 20 46	+39 47·5	1890	7½
69 Aquilæ	20 23·4	− 3 17	1880	5·2 (Whitley).
— Aquilæ	20 32 41	+ 0 37·6	1890	8½
3 Aquarii	20 41·4	− 5 28	1880	4·6 (Whitley).
ϵ Cygni	20 41 45	+33 33·4	1890	2¾
120 Espin Cygni	20 45 4	+45 26·7	1890	8½
— Delphini	20 46	+ 8 15	1885?	? (G.F.C.)
124 Espin Cygni	21 6 40	+47 12·4	1890	7½
7 Pegasi	21 36·8	+ 5 11	1890	5·4 (Whitley).
129 Espin Cygni	21 37 53	+48 41·5	1890	8¾
130 Espin Cephei	21 38 41	+70 17·1	1890	8
47 Capricorni	21 40 24	− 9 47·0	1890	6½
ν Pegasi	21 59·6	+ 4 28	1880	4·8 (Whitley).
134 Espin Lacertæ	22 6 30	+39 9·9	1890	7¼
35 Pegasi	22 22 17	+ 4 8·7	1890	5
β Piscis Australis	22 25 15	−32 54·6	1890	5

Star.	R.A.	Decl.	Epoch.	Mag.
λ Pegasi - - -	22 40·9	+22 56	1880	4·2 (Whitley).
g^2 Aquarii - - -	22 41 39	−20 31·0	1890	$5\frac{1}{2}$
μ Pegasi - - -	22 44·2	+23 58	1880	3·7 (Whitley),
λ Aquarii - - -	22 46 52	− 8 9·9	1890	$3\frac{3}{4}$
ϑ Aquarii - - -	22 48·3	−16 28	1880	3·4
138 Espin Lacertæ - -	22 52 25	+42 25·1	1890	7
— Piscium - - -	22 55 39	+ 0 29·6	1890	$8\frac{1}{2}$
56 Pegasi - - -	23 1·3	+24 49	1880	4·9 (Whitley).
94 Aquarii - - -	23 13 28	−14 3·4	1890	$5\frac{1}{4}$
262 Bess. Pegasi - -	23 14 44	+22 29·4	1890	7
46112 Lal. Pegasi - -	23 27 0	+23 14·3	1890	7
78 Pegasi - - -	23 38 27	+28 45·1	1890	5
ρ Cassiopeiæ - - -	23 48 53	+56 53·2	1890	$4\frac{1}{2}$
W.B. XXIII, 1090 Piscium -	23 54 56	+ 0 27·1	1890	$8\frac{3}{4}$

SECTION FOR THE OBSERVATION

OF

MARS.

DIRECTOR.—E. M. ANTONIADI, F.R.A.S.

REPORT OF THE SECTION, 1898—1899.

PART I.

PROLEGOMENA.

1. The Apparition of 1898–1899.

This opposition of Mars was, on the whole, a favourable one. Although the planet which, in 1896, approached us to within 0·561 (52,040,000 miles), was not nearer than 0·651 (60,390,000 miles) on 1899, January 15, yet its great northern declination atoned, to European astronomers, for its reduced disc, which, even at maximum, was not greater than 14″·76.

Phenomena.

Passage of Mars through Perihelion	1898, April 30.
Summer Solstice of S. hemisphere Winter Solstice of N. hemisphere	1898, May 31.
Autumnal Equinox of S. hemisphere Spring Equinox of N. hemisphere	1898, Nov. 6.
Passage of Mars through Aphelion	1899, April 8.
Winter Solstice of S. hemisphere Summer Solstice of N. hemisphere	1899, May 24.

The latitude of the centre of the disc was negative early in the apparition, but became positive on 1898, August 19, when the earth passed through the plane of the Martian equator.

2. The Work of the Section.

The following are the names of the Members having joined the Mars Section in 1898–1899.

Observer.	Locality.	Aperture of Instrument in Inches.	No. of Drawings sent to the Association.
ANTONIADI, E. M., F.R.A.S.	Juvisy, *France* -	$\left\{\begin{matrix}10\frac{1}{2}\text{ O.G.}\\6\frac{1}{2}\text{ Spec.}\end{matrix}\right\}$	65
ATTKINS, E. - -	Highgate, London -	$6\frac{1}{2}$ Spec.	11
BROWN, G. L. - -	Stirling, Scotland -	$10\frac{1}{4}$ Spec.	5
CORDER, H. - - -	Bridgewater -	$6\frac{1}{2}$ Spec.	12
CROWLEY, L. A. - -	Paris, *France* -	7 O.G.	5
HALL, W. J. - -	Nantwich, Cheshire	$4\frac{7}{8}$ Spec.	5
KEMPTHORNE, Rev. P. H., M.A., F.R.A.S.	Wellington College, Berkshire.	$12\frac{1}{2}$ Spec.	5
KILLIP, Rev. R., F.R.A.S. -	St. Annes-on-the-Sea, Lancashire.	5 O.G.	5
MEE, A., F.R.A.S. - -	Cardiff, Wales -	$8\frac{1}{2}$ Spec.	3
MOLESWORTH, Capt. P. B., R.E., F.R.A.S.	Trincomali, *Ceylon*	$12\frac{1}{2}$ Spec.	* 0
PHILLIPS, Rev. T. E. R., M.A., F.R.A.S.	Yeovil, Somerset -	$9\frac{1}{2}$ Spec.	20
TOWNSHEND, H. J. - -	Leeds - -	$9\frac{1}{2}$ Spec.	† 0
WILLIAMS, A. A. - -	Cardiff, Wales -	5 Spec.	7
WILLIAMS, A. STANLEY, F.R.A.S.	Brighton - -	$6\frac{1}{2}$ Spec.	1

A comparison of the preceding Table with those given in the last "Reports" will show a diminution in the membership as well as in the geographical extent of the Section—a change which, instead of going the other way, that is *pari passu* with the great increase in the Membership of the Association, seems to have unexpectedly followed the constant reduction of the Martian disc since 1892. If the change be cyclical, we may look forward for fuller collaboration in the immediate future.

It is fortunate, however, that, through the exertions of our European Members, there is no corresponding decline in the value of the results obtained.

* Capt. Molesworth was enabled to make 172 drawings of the planet during the apparition. These, however, were not presented to the Association, but merely sent to the Director for inspection. A summary of the Ceylon results is given in the present Report.

† The drawing shown on Plate III. Fig. 3., was only temporarily lent to the Director.

A complete list of the 144 drawings of Mars sent to the Association in 1898–99 is given in the following Table :—

D stands for the diameter of the disc ; ω and ϕ represent the longitude and the latitude of the centre of the disc.

No.	Observer.	Date.	D.	ω	ϕ
			"	°	°
1	Corder	1899, Jan. 19	14·7	0	+11·5
2	Antoniadi	„ Feb. 27	11·5	16	+ 8·7
3	Antoniadi	„ Feb. 25	11·7	24	+ 8·6
4	Antoniadi	„ Feb. 20	12·3	28	+ 8·5
5	Phillips	„ Feb. 26	11·6	29	+ 8·6
6	Corder	„ Jan. 14	14·8	32	+12·2
7	Phillips	„ Mar. 1	11·3	32	+ 8·7
8	Kempthorne	„ Feb. 21	12·1	34	+ 8·5
9	Brown	„ Jan. 16	14·8	36	+11·9
10	Antoniadi	„ Feb. 20	12·3	38	+ 8·5
11	Antoniadi	„ Feb. 25	11·7	39	+ 8·6
12	Antoniadi	„ Feb. 24	11·9	42	+ 8·6
13	Attkins	„ Feb. 24	11·9	42	+ 8·6
14	Antoniadi	„ June 17	5·3	44	+23·7
15	A. A. Williams	„ Feb. 26	11·6	44	+ 8·6
16	Corder	„ Jan. 13	14·7	48	+12·5
17	Antoniadi	1898, July 14	5·6	49	−10·3
18	Antoniadi	„ Aug. 19	6·2	51	− 0·2
19	Antoniadi	1899, Feb. 24	11·9	53	+ 8·6
20	Antoniadi	„ July 23	4·7	55	+26±
21	Stanley Williams	„ Feb. 23	11·9	57	+ 8·6
22	Killip	„ Feb. 22	12·0	58	+ 8·5
23	Hall	„ Jan. 14	14·8	59	+12·3
24	Phillips	„ Jan. 13	14·7	59	+12 4
25	Antoniadi	„ Feb. 24	11·8	60	+ 8·6
26	Kempthorne	„ Feb. 23	11·9	60	+ 8·6
27	Corder	„ Jan. 13	14·7	63	+12·5
28	Phillips	„ Apr. 3	8·5	70	+12·0
29	Attkins	„ Feb. 23	11·9	71	+ 8·6
30	Corder	„ Feb. 16	12·7	72	+ 8·6
31	Phillips	„ Jan. 14	14·8	73	+12·3
32	Antoniadi	„ Feb. 17	12·6	79	+ 8·6
33	Antoniadi	„ Jan. 9	14·7	85	+13·1
34	Crowley	„ Feb. 17	12·6	86	+ 8·6
35	Antoniadi	„ Feb. 17	12·6	87	+ 8·6
36	Crowley	„ Jan. 9	14·7	87	+13·1
37	Phillips	„ Feb. 14	12·9	91	+ 8·7
38	Antoniadi	„ Jan. 9	14·7	92	+13·1
39	Antoniadi	„ Feb. 17	12·6	94	+ 8·6
40	Antoniadi	1898, July 8	5·5	99	−12·0
41	Antoniadi	1899, Feb. 17	12·6	101	+ 8·6
42	Antoniadi	„ Jan. 8	14·6	101	+13·2
43	Attkins	„ Feb. 17	12·6	106	+ 8·6
44	Antoniadi	„ Feb. 17	12·6	109	+ 8·6
45	Antoniadi	„ Jan. 8	14·6	116	+13·2
46	Phillips	„ Jan. 8	14·6	118	+13·2
47	Antoniadi	1898, Oct. 22	8·5	123	+13·7
48	Attkins	1899, Mar. 27	8·9	124	+11·1
49	Attkins	„ Feb. 17	12·6	130	+ 8·6
50	Antoniadi	1898, Oct. 22	8·5	131	+13·7
51	Antoniadi	1899, July 14	4·8	143	+25·8

No.	Observer.	Date.	D.	ω.	φ.
			″	°	°
52	Antoniadi	1899, Feb. 10	13·3	153	+ 8·9
53	Phillips	„ Jan. 4	14·3	153	+13·8
54	Hall	„ Feb. 12	13·1	156	+ 8·8
55	Crowley	„ Feb. 10	13·3	158	+ 8·9
56	Antoniadi	1898, Sept. 13	6·9	159	+ 6·4
57	A. A. Williams	1899, Jan. 4	14·3	167	+13·9
58	Antoniadi	„ Feb. 10	13·3	168	+ 8·9
59	Crowley	„ Feb. 10	13·3	171	+ 8·9
60	Hall	„ Jan. 4	14·3	171	+13·8
61	Antoniadi	„ Mar. 16	9·9	178	+ 9·8
62	Killip	„ Mar. 15	10·0	178	+ 9·6
63	Phillips	1898, Dec. 31	14·2	180	+14·4
64	Antoniadi	1899, Mar. 14	10·0	189	+ 9·6
65	Antoniadi	„ June 2	5·7	189	+21·6
66	Antoniadi	„ July 9	4·9	189	+25·6
67	Antoniadi	„ Feb. 10	13·3	194	+ 8·9
68	Antoniadi	„ June 1	5·7	194	+21·5
69	Corder	„ Feb. 7	13·6	196	+ 9·0
70	Antoniadi	„ Feb. 10	13·3	201	+ 8·9
71	Crowley	„ Feb. 10	13·3	203	+ 8·9
72	Kempthorne	„ Feb. 2	14·0	205	+ 9·6
73	Hall	„ Feb. 3	13·9	206	+ 9·4
74	Attkins	„ Mar. 14	10·0	207	+ 9·6
75	Phillips	„ Feb. 1	14·1	210	+ 9·7
76	Antoniadi	„ Feb. 4	13·9	214	+ 9·4
77	Antoniadi	„ May 30	5·8	217	+21·3
78	Antoniadi	1898, Nov. 18	10·3	217	+16·3
79	Corder	1899, Feb. 1	14·1	224	+ 9·6
80	Antoniadi	„ Feb. 4	13·9	225	+ 9·4
81	Brown	„ Feb. 1	14·1	225	+ 9·7
82	Antoniadi	„ Jan. 28	14·3	228	+10·1
83	Antoniadi	„ May 30	5·8	228	+21·3
84	Attkins	„ Feb. 3	13·9	234	+ 9·4
85	Mee	„ Feb. 2	14·0	235	+ 9·6
86	Antoniadi	„ Jan. 28	14·3	236	+10·1
87	Antoniadi	„ Feb. 2	14·0	242	+ 9·6
88	Phillips	1898, Dec. 25	13·8	245	+15·1
89	Phillips	1899, Apr. 21	7·3	245	+14·9
90	Phillips	„ Mar. 14	6·3	249	+ 9·6
91	Antoniadi	1898, Dec. 21	13·4	249	+15·5
92	Hall	1899, Feb. 2	14·0	251	+ 9·5
93	Corder	1898, Dec. 27	13·9	253	+14·8
94	Antoniadi	1899, Apr. 19	7·5	254	+14·6
95	Attkins	„ Mar. 14	10·0	255	+ 9·6
96	Kempthorne	„ Feb. 2	14·0	255	+ 9·6
97	Antoniadi	1898, Dec. 21	13·4	257	+15·5
98	Antoniadi	1899, Feb. 2	14·0	257	+ 9·6
99	Antoniadi	„ May 27	5·9	257	+20·8
100	A. A. Williams	„ Feb. 2	14·0	259	+ 9·6
101	Antoniadi	„ Apr. 19	7·5	261	+14·6
102	A. A. Williams	1898, Dec. 26	13·8	262	+15·0
103	Killip	1899, Mar. 13	10·1	266	+ 9·5
104	Antoniadi	1898, Dec. 21	13·4	268	+15·5
105	Mee	1899, Jan. 27	14·4	268	+10·6
106	Antoniadi	1898, Dec. 20	13·3	269	+15·6
107	Antoniadi	„ Dec. 22	13·5	270	+15·4
108	Phillips	1899, Feb. 1	14·1	272	+ 9·7
109	Corder	„ Jan. 26	14·5	273	+10·4
110	Phillips	1898, Dec. 20	13·3	276	+15·6
111	Antoniadi	„ Dec. 22	13·5	277	+15·4

No.	Observer.	Date.	D.	ω	φ
			″	°	°
112	Antoniadi - -	1898, Dec. 20 -	13·3	278	+15·6
113	Brown - -	1899, Jan. 26 -	14·5	280	+10·5
114	Antoniadi - -	1898, Dec. 20 -	13·3	284	+15·6
115	Brown - -	1899, Jan. 25 -	14·5	285	+10·6
116	Attkins - -	„ Jan. 26 -	14·5	288	+10·5
117	Phillips - -	„ Mar. 10 -	10·4	290	+ 9·2
118	Mee - -	„ Jan. 25 -	14·5	292	+10·6
119	Antoniadi - -	1898, Nov. 11 -	9·8	297	+15·9
120	Phillips - -	1899, Jan. 30 -	14·2	301	+ 9·9
121	Antoniadi - -	1898, Nov. 11 -	9·8	306	+15·9
122	Killip - -	1899, Jan. 26 -	14·5	306	+10·5
123	Attkins - -	„ Mar. 2 -	11·2	309	+ 8·7
124	Phillips - -	1898, Dec. 17 -	13·0	309	+15·9
125	Antoniadi - -	1899, Jan. 25 -	14·5	309	+13·1
126	A. A. Williams -	„ Jan. 26 -	14·5	314	+10·4
127	Corder - -	„ Jan. 22 -	14·6	319	+10·9
128	Antoniadi - -	„ Feb. 27 -	11·5	320	+ 8·6
129	Antoniadi - -	„ Jan. 25 -	14·5	320	+10·6
130	Killip - -	„ Jan. 24 -	14·5	321	+10·7
131	A. A. Williams -	„ Mar. 5 -	10·9	325	+ 8·9
132	Antoniadi - -	„ Feb. 27 -	11·5	327	+ 8·6
133	Antoniadi - -	„ Jan. 25 -	14·5	328	+10·6
134	Brown - -	„ Jan. 23 -	14·6	330	+10·9
135	Kempthorne -	„ Jan. 27 -	14·4	330	+10·3
136	Corder - -	„ Jan. 19 -	14·7	331	+11·5
137	A. A. Williams -	„ Jan. 23 -	14·6	332	+10·9
138	Antoniadi - -	„ Feb. 27 -	11·5	334	+ 8·6
139	Phillips - -	„ Apr. 9 -	8·0	337	+13·0
140	Antoniadi - -	„ July 30 -	4·7	340	+25·0
141	Attkins - -	„ Feb. 27 -	11·5	345	+ 8·6
142	Corder - -	„ Jan. 19 -	14·7	345	+11·5
143	Antoniadi - -	„ July 29 -	4·7	347	+26±
144	Phillips - -	„ Jan. 24 -	14·5	357	+10·7

The Section may be congratulated on having amongst its Members such skilful observers as Capt. Molesworth and the Rev. T. E. R. Phillips. The recent areographic work of the former, based on 172 drawings of the planet, is a worthy sequel to that made at the 1896–97 apparition, though the observer was now obliged to absent himself during the most favourable part of the planet's visibility. Meantime, the Rev. T. E. R. Phillips was even more successful in 1898–99 than two years previously. His results have been so fully confirmed from all quarters as to stamp him as one of the very first observers in the British Isles. Also, by his detection of the canals as edges to diffused shadings, the Rev. P. H. Kempthorne did more than anybody else in these days to increase our knowledge of those enigmatical lines. Work of a high order was further done by Messrs. Attkins and Brown, Hall, Corder, Mee, and A. A. Williams, while Messrs. Killip and Townshend supplied valuable drawings and notes. It is, however, to be regretted that the Section did not have the advantage of the full collaboration of Mr. Stanley Williams, though the few diagrams and notes sent are worthy of his work in the past.

3. On the Representation of Uncertain Detail.

Rev. T. E. R. Phillips reports as follows on this important point:—

"Faint markings have been glimpsed now and then, and it "would be easy, by the 'scientific use of the imagination,' to "conjure them into lines and streaks harmonising with Schia- "parelli's charts, but I am careful to represent on my drawings "only what I feel I can see with certainty and hold with "tolerable steadiness."

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4. The Canals.

Notwithstanding the natural scepticism of many scientific men, every opposition brings with it its own contingent of confirmation of Schiaparelli's discovery of linear markings, apparently furrowing the surface of the planet Mars. The differentiation between objective and subjective in the dædalian phenomena presented by these appearances will be the work of future generations. But the value of the great Italian's results will be everlasting.

As at the last apparition, the canals have been seen by all the Members of the Section. Some notes as to their visibility will certainly be of interest here.

"I may say," says Mr. Attkins, "that I started work on Mars "in the hope that I should not see any of the so-called 'canals,' "and I was very much astonished at what I did see. I have, "however, no doubt about those I have shown, as every detail on "both occasions stood out perfectly defined, the air being very "steady and clear."

Writing under date 1898, December 16, the Rev. T. E. R. Phillips says:—

"Such canals as I have certainly seen have been very broad and "diffused, reminding one forcibly of Mr. Mee's 'amorphous "smudges.' I have no doubt this appearance is due to im- "perfect seeing, and that, could I have observed under better "conditions, the markings would have seemed narrower and more "distinct." But on 1899, January 30:—"The canals in the "neighbourhood of the *Nilosyrtis* seemed almost Schiaparellian "in their sharpness and definiteness."

Now, next to observers so emphatic on the question, some Members of the Section might, perhaps, protest in finding their names included among the canal-seers.

"I have never joined the Mars Section, because I cannot see "canals," says Mr. Henry Corder, the valued late Director of the Meteoric Section of the Association, and no statement as to the contrary would be made here were the present "Memoir" to be a mere compilation of reports. But, inasmuch as the material composing it is based on a careful analysis of every shading shown on the drawings to hand, it would be illogical to speak of some shadings, and say nothing of others. Like Mr. Mee, Mr. Corder shows diffuse markings at the exact positions of, and having a similar trend to, the Schiaparellian "canals." Hence the justification for including these features under that conventional name, And, it might be, that this very apparent incongruity pays the

highest tribute to the accuracy of Messrs. Corder and Mee's observations.

The following Table shows the number of canals shown by the Members of the Section on their recent drawings :—

Observer.	Canals.				
	Schiap.	Lowell.	"New" 1896–97.	New, 1898–99.	Total.
Capt. Molesworth	75	3	4	3	85
Rev. T. E. R. Phillips	44	0	1	0	45
Antoniadi	41	0	2	1	44
Brown	35	1	1	1	38
Rev. P. H. Kempthorne	26	2	0	0	28
Attkins	22	0	1	0	23
Stanley Williams	17	0	0	0	17
Corder	15	0	1	0	16
Hall	10	0	1	0	11
Rev. R. Killip	9	0	0	0	9
Mee	7	0	0	0	7
Crowley	2	0	0	0	2
A. A. Williams	1	0	1	0	2
Townshend	0	0	1	0	1

The total number of canals seen by the Section in 1898–99 is exactly 99. Of these, 84 belong to Schiaparelli's charts, six to Lowell's, four to our 1896–97 chart, one to Cerulli's map of 1896, while four others were apparently seen for the first time at the past apparition.

A complete exposition of the names or symbols of these canals is given in the four following tables. Duplicity is indicated by a (*d*).

I. SCHIAPARELLI'S MAPS (1877–88).

Adamas.	*Ceraunius* (*d*).	*Galaxias.*
Æsacus.	*Cerberus* (*d*).	*Ganges* (*d*).
Æthiops.	*Chaos.*	*Gehon* (*d*).
Agathodæmon.	*Chrysorrhoas.*	*Gigas.*
Alcyonius.	*Clarius.*	*Gorgon* (*d* ??).
Amenthes.	*Cyclops* (*d*).	*Granicus.*
Antæus.	*Dardanus.*	*Gyndes.*
Anubis.	*Deuteronilus.*	*Hades* (*d*).
Arnon.	*Eosphoros.*	*Hebrus.*
Asclepius.	*Erebus.*	*Heliconius.*
Astaboras.	*Eumenides-Orcus.*	*Hiddekel.*
Astapus.	*Eunostos.*	*Hyblæus.*
Astusapes.	*Euphrates.*	*Hydaspes.*
Athyr.	*Euripus.*	*Hydraotes.*
Boreas.	*Eurotas.*	*Iamuna* (*d*).
Boreosyrtis.	*Fevos.*	*Iaxartes.*
Callirrhoe.	*Fortuna.*	*Indus.*

I. SCHIAPPARELLI'S MAPS (1877–88)—*continued.*

Iordanis.	*Orontes.*	*Sirenius.*
Iris.	*Oxus.*	*Styx.*
Issedon.	*Pactolus.*	*Tanais.*
Kison.	*Phasis.*	*Tartarus.*
Læstrygon.	*Phison.*	*Thoth.*
Lethes.	*Phlegethon.*	*Titan.*
Nectar.	*Pierius.*	*Triton.*
Nepenthes.	*Plutus.*	*Typhonius.*
Nilokeras (*d*).	*Poros.**	*Uranius.*
Nilosyrtis.	*Protonilus.*	*Xanthus.*
Nilus (*d*).	*Pyriphlegethon.*	*Xenius.*

* A name given provisionally by the Director to Schiaparelli's unnamed canal, forming *Pharos Insula,* and putting into communication *Sinus Sabæus* with the *Syrtis Major.* Πόρος, in Greek, is a narrow *passage, strait,* or *channel.*

II. LOWELL'S CHART (1894).

"*Arosis.*"	"*Cantabras.*"	"*Eulæus.*"
"*Brontes.*"	"*Elison.*"	"*Hypsas.*"

III. CANALS OF THE 1896–97 CHART.

Ω and Φ represent areographic longitude and latitude respectively.

Symbol, 1896–97.	Name.	Discovered by.	Extent (1898–99). From Ω	From Φ	To Ω	To Φ
			°	°	°	°
A	"*Iamuna II.*"* -	Molesworth, 1896	35	− 1	40	−12
E	"*Hyblæus II.*"* -	„ „	208	+33	214	+ 9
I	"*Rhesus*"† -	Stanley Williams, 1890.	254	− 3	279	+ 8
L	"*Nasamon*"‡ -	Lowell, 1894 -	265	+40	282	+30
—	"*Sitacus*"§ -	Cerulli, 1896 -	298	+40	354	+ 8

* Names given by Captain Molesworth.

† Christened by Cerulli.

‡ Name given to this canal by the Director, from its African vicinity. Lowell and Cerulli both call it "*Astapus,*" though its course makes an angle of 45° with Schiaparelli's *Astapus.* Hence the necessity of a new name for this important marking.

§ Lowell called "*Sitacus*" a line running from the preceding fork of *Sinus Sabæus* to the northern end of *Syrtis Major.* But the canal seen by the Members of the Section in 1898–99 unites the same fork to *Coloe Palus,* thus being identical with Cerulli's "*Sitacus.*"

IV. NEW CANALS SEEN IN 1898–99.

Symbol, 1898–99.	Name (in Cerulli's Map, 1900).	Discovered by.	Extent. From Ω	Extent. From Φ	Extent. To Ω	Extent. To Φ
			°	°	°	°
A	- - -	Molesworth -	42	+43	98	+30
B	- - -	,, -	106	+30	150	+20
C	- - -	Brown - -	220	+19	232	+14
D	"*Axon*" - -	Antoniadi - -	232	+30	265	+40
		Molesworth - -				

It is evident from the above tables that very few canals were seen double in 1898-99.

CANALS IN THE DARK REGIONS.—"I have been fortunate "enough to trace several of Lowell's canals traversing the *Maria*. "These features appear to me in prolongation of, and are "obviously connected with, the true canals."—(Captain Molesworth.)

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5. The Canals considered as Edges to Faint Shadings. A Step towards the Solution of the Mystery.

The most important feature of the apparition in connexion with the canals is the detection, made by the Rev. P. H. Kempthorne, that a considerable number of them are merely the edges of diffused shadings. At least a dozen canals were thus seen by the Rev. P. H. Kempthorne. Such observations are of the highest import, as throwing immense light on an obscure corner of science. Probably optical phenomena have something to do with the visibility of the canals. Meantime, the sensibility of some eyes in detecting almost insensible half-tones stands in curious opposition to the inability of others in that line.

Messrs. Corder, Molesworth, Phillips, A. A. Williams, and the Director, also saw a very few canals as borders to faint dusky areas. But the stone added to the edifice of truth here by Mr. Kempthorne is weightier alone than the sum of those brought by the other Members of the Section together.

The idea that some of the canals might be due to the edges of shadings was enunciated by Mr. Maunder in 1882.

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6. The Lakes.

The number of lakes shown by each Member of the Section on the drawings to hand is as follows :—

Observer.	Lakes.			
	Schiap.	Lowell or Cerulli.	"New."	Total.
Capt. Molesworth	14	5	6	25
Rev. T. E. R. Phillips	12	2	3	17
Antoniadi	13	0	1	14
Brown	8	1	4	13
Attkins	7	0	1	8
Rev. P. H. Kempthorne	6	0	1	7
Hall	6	0	1	7
Stanley Williams	4	0	0	4
Corder	2	0	1	3
Mee	1	0	1	2
Crowley	2	0	0	2
Rev. R. Killip	1	0	0	1
A. A. Williams	1	0	0	1
Townshend	0	0	0	0

In all 33 lakes are recorded. Of these, 18 are Schiaparelli's, 4 Lowell's, 1 Cerulli's, and 10 new. The latter seem to have mostly been seen for the first time in 1898–99.

I. SCHIAPARELLI'S MAPS (1877–88).

Arethusa Lacus.	*Mœotis Palus.*	*Siloe Fons.*
Coloe Palus.	*Mœris Lacus.*	*Sirbonis Palus.*
Hecates Lacus.	*Niliacus Lacus.*	*Solis Lacus.*
Hephæstus.	*Nodus Gordii.*	*Stymphalius Lacus.*
Ismenius Lacus.	*Phœnicis Lacus.*	*Tithonius Lacus.*
Lunæ Lacus.	*Propontis.*	*Trivium Charontis.*

II. LOWELL'S CHART (1894).

"*Ammonium.*"	"*Lucus Maricæ.*"
"*Castalia Fons.*"	"*Nodus Gordii.*"

N.B.—Schiaparelli called *Nodus Gordii* the intricate dusky rendezvous of *Eumenides*, *Sirenius*, and *Gigas*, with centre at $\Omega = 127°$, $\Phi = 0°$. This is not Lowell's "*Nodus Gordii*," a small dot strung on the *Eumenides* towards $\Omega = 146°$. The beaded appearance of the canal *Eumenides-Orcus* was first recognised by Mr. Walter F. Gale, F.R.A.S., of Sydney, New South Wales, during the very favourable apparition of 1892.

III. CERULLI'S CHART (1900).

"*Pambotis Lacus*," on intersection of *Cyclops*, *Cerberus*, *Eunostos*, &c.

IV. NEW LAKES (1898–99).

Symbol.	Discoverer.	Approximate Position. Ω	Φ	Symbol.	Discoverer.	Approximate Position. Ω	Φ
		°	°			°	°
*a**	Phillips -	20	+ 30	*f*	Brown - -	225	+ 39
b	Molesworth -	100	+ 29	*g*	Brown - -	262	+ 34
	Phillips - -			*h*	Several observers.	280	+ 54
c	Molesworth -	122	− 9				
d	Molesworth -	167	+ 28	*i*	Molesworth -	312	+ 25
e	Brown - -	217	+ 39	*j*	Molesworth -	348	+ 18

* Different from the lake *a* of our 1896–97 chart.

7. The Colours of the Disc.

"Little colour has been noted on the disc," says Mr. Attkins. "Occasionally a very faint red on certain regions has been seen, "and also a bright yellow tint has been noticed. The seas have "generally appeared greyish (rather dark) with, perhaps, a faint "shade of green."

A blue tinge has often been noted in the *Maria* by Capt. Molesworth. Mr. Hall found them rather greenish. On January 4, Rev. T. E. R. Phillips remarked that the "planet appeared very "ruddy in morning light."

8. The Projections on the Terminator.

Capt. Molesworth forwards the following notes concerning these phenomena:—

"1898, August 15.—Projection near N. end of terminator, "actual not optical (*Baltia*?)

"August 19.—Optical (*Edom*).

"August 21.—Optical (white patch near *Hammonis Cornu*).

"September 9.—Slight bulge suspected on terminator close to its N. end (*Arcadia*?).

"September 12.—Minute white point suspected close to terminator just N.E. of *Lacus Phœnicis* (not a true projection).

"No irregularities noticed on limb."

9. The Fading of the Maria.

"The most noteworthy point during the period of these "observations," says Capt. Molesworth, "was the faintness of "all the *Maria* during August. The fading began towards the "end of July (50 to 60 days after the winter solstice of the N. "hemisphere). The *Maria* were so faint towards the end of "August and beginning of September that they were only "perceptible with great attention. The first sign of darkening "was noted on September 20 (112 days after the solstice and "48 before the equinox). After this date the *Maria* rapidly "recovered their normal darkness. It will be noticed that this "recovery of tone was just antecedent to the unveiling of the "N. polar cap, which was very indefinite up to September 28. "The faintness of the *Maria* was not caused by cloud or mist, "as, with sharp definition, the details, although so faint, were "seen quite distinctly; the edges of the *Maria* being clear cut, "and not 'fuzzy' as if obscured in any way. The fading appears "to have been due to a definite change in the *Maria* themselves, "and was shared by the larger lakes, *Lacus Solis*, *Lacus Lunæ*, "*Mare Acidalium*, *Trivium Charontis*, &c. These observations "confirm those of Lowell in 1894, when a similar general fading "of the *Maria* was noticed about 60 days after summer solstice "of the S. hemisphere (Lowell 'Mars,' 1896, p. 120). The "change, therefore, is probably seasonal, and possibly connected "with the development of the N. polar cap and its sudden "return to distinctness" (*see* p. 102).

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10. On the Transparency of the Martian Atmosphere.

On 1899, January 25, the Director found the *Mare Tyrrhenum* very dark right up the *p* limb, an observation which has been frequently confirmed subsequently. The *Boreosyrtis* also was almost black when rising on the limb or terminator. This remarkable visibility of dark spots through so thick an atmospheric layer shows us, beyond doubt, that the gaseous envelope of Mars is exceedingly transparent, and, to a large extent, destitute of anything capable of scattering sunlight. On Mars, therefore, the sky ought to be nearly black in broad daylight, a circumstance which would enable faint stars to be easily visible.*

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* This idea was suggested by M. Flammarion and the Director in their joint paper on Mars, 1898–99, published in the *Bulletin de la Société Astronomique de France*, for September 1899.

PART II.

THE OBSERVATIONS.

Introductory.

In dealing with so large a number of drawings, Mr. Maunder's excellent programme of 1892 was followed in arbitrarily dividing the planet's surface into eight sections, of which six, having a mean breadth of 60° in longitude, extend from + 60° to — 60° of latitude, while the remaining two sections deal with the polar regions.

Section.	Breadth.	Limits of Ω	Limits of Φ	Region.	Drawings.
I.	60°	310° to 10°	+60° to −60°	*Sinus Sabæus* -	20
II.	45	10 „ 55	+60 „ −60	*Auroræ Sinus* -	19
III.	65	55 „ 120	+60 „ −60	*Solis Lacus* -	26
IV.	60	120 „ 180	+60 „ −60	*Mare Sirenum* -	17
V.	70	180 „ 250	+60 „ −60	*Mare Cimmerium*	28
VI.	60	250 „ 310	+60 „ −60	*Syrtis Major* -	34
VII.	360	0 to 360	−60 to −90	South Polar Region	144
VIII.	360	0 „ 360	+60 „ +90	North Polar Region	144

As in 1896–97, Schiaparelli's charming areographical nomenclature has been adopted here to the exclusion of any other. The dark areas have been systematically alluded to as seas, or anything signifying water (*Mare*, *Sinus*, *Fretum*, *Lacus*, *Palus*, "marsh," "shoal," "canal," &c.). The yellow background has received names conveying the idea of land (*Insula*, *Chersonesus*, *Promontorium*, *Pons*, "coast," &c.). All this is mere convention. We have no direct proof of the existence of water on Mars, while we seem to have some vague suspicions as to its absence. The kinetic theory of gases, as developed by Daniel Bernouilli, Joule, Maxwell, and Clausius, and, especially, as applied to planetary atmospheres by Dr. Johnstone Stoney, tends to show us the critical velocity on Mars to fall short of the maximum probable speed of the molecules of aqueous vapour. In that case the white polar caps would not be ordinary snow caps, but caps of solid carbonic acid. This heavy gas condenses, in fact, into an intensely white solid Viewed in the face of our own earth's snow caps, the idea of endowing Mars with caps of such a deleterious substance seems far fetched. It must be borne in mind, however, that Maxwell's "probable maximum speed" is not a demonstrated verity, and that it is not at all certain that aqueous vapour is absent on Mars either. We gladly quit this field, lying, as it does, entirely beyond the pale of accurate knowledge.

SECTION I.

Sinus Sabæus and Mare Erythræum.

$\Omega = 310°$ to $10°$; $\Phi = +60°$ to $-60°$.

[The words *East* and *West* are invariably used in their areographic sense.]

HAMMONIS CORNU.—This striking promontory is shown blunted by Corder and A. A. Williams. Brown saw it exactly as depicted on Schiaparelli's Charts, with a short canal* running on the mainland behind, from *Syrtis Major* to *Sinus Sabæus*, thus showing the Cape to be the S.E. point of *Pharos Insula*. Attkins found the *Cornu* "well-defined, rather pointed and whitish," and is supported in this by Phillips and Antoniadi. Molesworth also notes "that the region near *Hammonis Cornu* was . . . very "bright on (1898) August 21." On January 27, Kempthorne saw the promontory united to a white patch in the *Mare* southwards, at $\Omega = 312$, $\Phi = -18°$, extending as far as *Scylla et*

Fig. 1, January 27.
(*Kempthorne.*)

Fig. 2, January 30.
(*Phillips.*)

Hammonis Cornu in January 1899.

Charybdis, and thus severing *Sinus Sabæus* from *Hellespontus* (Fig. 1), an observation which received full confirmation at the hands of Phillips, three days later (Fig. 2).†

SINUS SABÆUS.—The *Sinus* was found "dark, but not so much "so as *Dawes's Bay*," by Attkins, January 19; and "very pale" February 26 and March 1. Most Members show it uniform in tint, *Xisuthri Regio* being much less marked than in 1896–97. This half tone was, however, an easy feature to Antoniadi on February 27. Molesworth noticed, on 1898, August 21, "a pale "greenish grey tinge in the *Sinus Sabæus*." *Portus Sigeus*, the embouchure of the *Euphrates* was, as usual, a marked feature of the *Sinus*, appearing as a dark triangular spot on the drawings of Brown, Corder, Kempthorne, Molesworth, and Antoniadi. *Dawes's Forked Bay*, itself, was very dark to all the Members

* *See* page 70.

† Rev. T. E. R. Phillips suspected this appearance as early as 1898, November 13, when he noted that he thought "the *Sinus Sabæus* seemed "separated from the *Syrtis Major* by a lighter rift."

having sent in drawings of this region. The forks are admirably represented by Molesworth and Phillips (Figs. 3 and 4), and

Fig. 3, November 3. (*Molesworth.*)

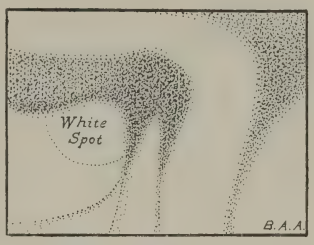

Fig. 4, January 24. (*Phillips.*)

The *Sinus Sabæus* region of Mars in 1898–99.

appeared sharp to Antoniadi on February 27 (Plate III., 6). They were, as a rule, incomparably darker than the canals to which they give rise, possibly as dark as any other region of the planet in 1898–99.

The bright coast all along the N. boundary of the *Sinus* is shown by Attkins and Killip (Plate III., 5).

FASTIGIUM ARYN is drawn shaded (the shading extending all over the space between the *Hiddekel* and the *Gehon*), by Kempthorne, who is supported here by Corder and Molesworth.

EDOM PROMONTORIUM.—"Its whiteness," says Phillips, "has "been such as to cast a glimmer of light across the *Sinus*, thus "almost uniting *Edom* with *Deucalionis Regio* by a bright "bridge." This cape was also white in 1896–97.

EDOM, itself, was described as "very bright," under $\omega = 330°$, by Brown, and "bright on limb," by Stanley Williams. In August 1898, Molesworth found it very white, "whereas at the "next presentation it was unusually dull, except when near the "terminator."

EDEN was seen slightly shaded by Brown, Corder, Kempthorne, and Molesworth, but Stanley Williams found it white on the limb.

THYMIAMATA appeared white near the terminator to Kempthorne.

AERIA.—Remarkably bright to Brown, even when central; seen bright when rising or setting by Attkins, Corder, Molesworth, and Antoniadi.

ARABIA.—Shaded on January 27, according to Kempthorne.

DIOSCURIA.—Slightly shaded on drawings by Brown and Corder.

CYDONIA was observed shaded on January 27, by Kempthorne.

SIRBONIS PALUS.—Brown shows the swamp as an extensive but faint shading, while Antoniadi glimpsed it as a small round

dark spot on January 25, the cross canals *Typhonius* and *Phison** being invisible.

ISMENIUS LACUS.—This spot was well seen by Molesworth. Antoniadi found it difficult; but Phillips describes it as "quite distinct and easy," on February 24. A vast change would seem to have occurred here between 1886 and 1888. In 1886, Schiaparelli found the longitude of *Ismenius Lacus* equal to 335°. In 1888, the longitude of the western nucleus of the doubled lake was 345°, the centre at 342°. Meantime, the whole system *Euphrates-Arnon-Kison* seemed to have rotated some 10° W., round *Portus Sigeus* as a centre. Prof. Schiaparelli thinks that the errors of observations would scarcely amount to 2° or 3°, so that the evidence seems to be in favour of objective change on the planet. Considering the importance of the phenomenon, some measures of the longitude of *Ismenius Lacus*, as drawn by Members of the Section in 1898–99, would not be out of place here:—

Date.	Ω.	Observer.	Date.	Ω.	Observer.
1898.	°		1898.	°	
Aug. 22 -	335	Molesworth.	Nov. 11 -	322	Molesworth.
Sept. 30 -	332	Molesworth.			
Oct. 1 -	331	Molesworth.	1899.		
„ 2 -	338	Molesworth.	Jan. 24 -	339	Phillips.
Nov. 6 -	332	Molesworth.	„ 30 -	333	Phillips.
„ 9 -	333	Molesworth.	Feb. 27 -	337	Antoniadi.

It is obvious from these figures:—

(*a*) That the longitude of the lake did not go on increasing since 1888; and

(*b*) That, according to every probability, it rather decreased, so as to return to its original position.

ARETHUSA LACUS was seen by Molesworth on 1899, July 19, 20, 21, and 22, when the planet's disc was reduced to 4″·7; a very remarkable achievement indeed. Its longitude seemed to be towards 331°, or more than 10° less than in 1888. This confirms the idea of the return of the *Euphrates-Arnon-Kison* line to its primitive position.

SILOE FONS† was difficult to Antoniadi.

* The co-ordinates of *Sirbonis Palus* in 1879 were:—Ω = 327°, Φ = + 14°. Those of the marking called *Lacus Sirbonis*, by Schiaparelli, in 1888, were:—Ω = 333°, Φ = + 12°. The shift in longitude seems to have followed the change in the direction of the *Euphrates*, described in the next paragraph.

† This is different from *Dirce Fons*, drawn by Schiaparelli in 1883–84, on the intersection of *Deuteronilus*, *Iordanis*, *Xenius*, and *Oxus*, at Ω = 354°, Φ = + 36°. *Siloe Fons* (1888) lies on the intersection of *Deuteronilus*, *Gehon I.* and *II.*, *Xenius*, *Oxus*, and *Siris*, at Ω = 7°, Φ = + 34°.

DEUCALIONIS REGIO is shown with its usual cigar shape by Corder, Molesworth, Phillips, A. A. Williams, and Antoniadi. All agree in drawing it fainter and duskier than the N. continent when in transit. The passage to the S. not very marked. The straight between *Deucalion* and *Thymiamata* is very dark on Killip's drawing, while Phillips does not represent it at all; having, moreover, seen the island much brighter and narrower than on Schiaparelli's charts. Molesworth shows the channel to the N. diffuse. *Deucalion* is one of those lands which brighten with the obliquity of the solar rays, and this phenomenon is very well depicted by Attkins.

NOACHIS has been drawn white on S. limb by Phillips, January 24.

HELLESPONTUS was seen dark by Kempthorne.

MARE ERYTHRÆUM.—All Members of the Section agree in giving to this area a greyish tinge. Owing, however, to the tilt of the axis, it was impossible, in 1898-99, to reconnoitre the appearance of the various half-tones with which its surface is diversified.

NEW LAKES:—

i $\Omega = 312°, \Phi = +25°$; detected by Molesworth.
j $\Omega = 348°, \Phi = +18°$; detected by Molesworth.

CANALS.

ARNON.—Seen by Molesworth: diffuse (1899, July 20, D. = 4″·7).

"AROSIS" (Lowell).—Partly shown by Kempthorne: diffuse.

"CANTABRAS" (Lowell).—Shown by Brown: diffuse.

DEUTERONILUS.—Brown: narrow.—Molesworth: diffuse.—Phillips: narrow.—Antoniadi: faint and difficult.

"EULÆUS (Lowell).—Seen diffuse by Molesworth, but not in the same course as Lowell's canal.

EUPHRATES.—Brown: narrow.—Molesworth: diffuse.—Phillips: rather broad.—Antoniadi: diffuse; very hard to see properly.

GEHON.—Attkins: single, running into *Niliacus Lacus*, February 24, but very broad February 27.—Brown: single, curved into *Mare Acidalium*, and very narrow.—Corder: edge of shading between it and *Hiddekel*.—Kempthorne: edge of shading between this canal and *Hiddekel*.—Killip: single, narrow.—Molesworth: diffuse at first, then sharp and single (November 3), and running as a curved line into *Sinus Acidalius*.—Phillips: invariably single and narrow, curving into the *Mare Acidalium*.—Stanley Williams: "seen conspicuously and undoubtedly double on March 2. Two distinct "streaks ran parallel to one another in a straight line from either inlet of "*Dawes's Forked Bay* to the *Mare Acidalium*. The canal was also seen "double on March 1. Schiaparelli's early maps of Mars show the *Gehon* "running in a curve to the *Mare Acidalium*, but it is noteworthy that on "the present occasion both components of the double canal seemed to run "in a perfectly straight line from *Dawes's Forked Bay* to the *Mare* "*Acidalium*. Considered as a single object the double *Gehon* was very "conspicuous."* Antoniadi: diffuse.

* Signor Cerulli supports Mr. Williams here. In spite, therefore, of the negative evidence afforded by other Members of the Section, the Director is inclined to consider the *Gehon* as having been really double in 1899.

On the Chart (Pl. IV.) both the single (curved) and the double (straight) views of this canal are shown.

HIDDEKEL.—Attkins: very narrow.—Corder: edge of shade between it and *Gehon*.—Kempthorne: edge of shade between this canal and the *Gehon*. —Molesworth: diffuse.—Phillips: narrow.—Antoniadi: faint and narrow.

KISON.—Seen by Molesworth on 1899, July 22, when the planet's disc was reduced to 4″·7.

ORONTES.—Brown: narrow.—Kempthorne: edge of shade in *Eden*.—Molesworth: diffuse.—Phillips: narrow.—Antoniadi: narrow, though somewhat diffuse.

OXUS.—Seen by Molesworth as bounding a shade in *Cydonia*, when the breadth of the canal subtended $\frac{1}{10}''$.

PHISON.—Brown: faint.—Kempthorne: edge of shade in *Arabia*.—Molesworth: diffuse.—Phillips: narrow.—Antoniadi: faint.

PIERIUS.—Brown: faint.—Molesworth: diffuse on 1899, June 16, D = 5″·4.—Antoniadi: diffuse.

"POROS."*—Shown by Brown: very narrow.

PROTONILUS.—Brown: well seen, narrow.—Kempthorne:—rather narrow, "edge of dusky area, quite sharp."—Molesworth: diffuse.—Phillips, narrow. —Antoniadi: narrow.

"SITACUS" (of Cerulli, not Lowell).—Corder: diffuse.—Antoniadi: very fine linear sensation; probably subjective.

TYPHONIUS.—Brown: narrow.—Molesworth: diffuse.—Antoniadi: difficult. [Molesworth saw this canal produced into *Hadriacum Mare*.]

XENIUS.—Corder: very diffuse and indefinite.—Molesworth: edge of shading in S. *Cydonia*.

SECTION II.

Margaritifer Sinus, Auroræ Sinus, and Mare Acidalium.

$\Omega = 10°$ to $55°$; $\Phi = +60°$ to $-60°$.

MARGARITIFER SINUS.—This marking is drawn with its usual Schiaparellian outline by Brown. All Members agree in showing it much lighter in tint than the neighbouring dark *Sinus Sabæus*. Lowell's "Pearl" does not seem to have been seen.

AROMATUM PROMONTORIUM is shown bright by Molesworth. Attkins, Molesworth, Phillips, A. A. Williams, and Stanley Williams agree in drawing it a little more blunted than usual, while Brown, Kempthorne, and Antoniadi do not seem to corroborate this view. A light bridge was seen uniting this promontory to *Ogygis Regio* by Kempthorne (Pl. I., 3).

CHRYSE was found white when on transit by Brown; with a bright border by Attkins, February 21.

* *See ante* p. 70.

AURORÆ SINUS is described as "very dark" by Attkins and Phillips. Brown shows it rather faint, so also Corder and Crowley; Kempthorne very dark; Molesworth "abnormally "faint during the period of faintness,"* adding that from it, three great darker streaks have been seen crossing the *Mare*, two of which are apparently Lowell's "*Hipparis*" and "*Erannoboas*," the third being not identifiable, running, as it does, "in prolonga- "tion of *Iamuna* to a point W. of *Thaumasia* near the estuary "of *Nectar*." A. A. Williams depicts the *Sinus* as rather faint, whilst Stanley Williams describes it "not very dark," in perfect agreement with Antoniadi. Two bridges are seen crossing *Auroræ Sinus* on Attkins' drawings. One of them is Lowell's "*Caicus*," the other Cerulli's "*Ogyges*." The latter was also seen by Hall.

LACUS NILIACUS.—Considerable confusion would seem to reign in the representation of this most interesting dark area. Attkins and Corder show it united to *Mare Acidalium*, the whole constituting a very marked, intensely dark spot, running S.W. Also, Hall (Fig. 10), Killip, and Molesworth (Fig. 5) did not clearly separate it from the sombre area to the N.

But Brown (Fig. 7), Kempthorne, Stanley Williams (Fig. 9), and Antoniadi (Fig. 8) show *Achillis Pons* as a very conspicuous feature, thus completely isolating the lake from below. Brown describes the *Lacus* as "a long ellipse," Kempthorne calls it "very dark," and Stanley Williams "not so dark as *Mare Acidalium*."

Phillips saw a lake (Fig. 6) E. of *Niliacus Lacus*, as stated at the end of this Section.†

ACHILLIS PONS was "at times very bright" to Brown and Kempthorne, invisible to Phillips, February 24, "plain and pretty bright" to Stanley Williams (Plate I., 4), and "one of the easiest "and most striking features of the planet" to Antoniadi (Plate I., 2). These discordances between observers are interesting, and show how the varying conditions of atmospheric steadiness and vacillating sensibility of the retina make us now detect extremely delicate details, and then miss some comparatively obvious markings.‡

MARE ACIDALIUM.—"Most astonishing sight," says Attkins, "quite the darkest and most prominent object on the disc. [On "January 19] at 11^h it was noted that this latter appeared *black*." Brown shows this spot very dark, with *Scheria Insula*, "occa- "sionally very bright," occupying its centre. All Members of the Section, having returned drawings of this region, dwell on the great darkness of *Mare Acidalium*, and agree in representing it as the darkest area of Mars. It is thus shown on the drawings

* *See* p. 74.

† The Director is not quite sure that this is not *Siloe Fons*.

‡ On 1894, September 27, *Solis Lacus* was almost invisible to the Director when near the meridian for three consecutive hours, when, at last, upon nearing the *p* limb it suddenly appeared, for a fraction of a second, as an ink-black spot. Were the watch shorter, the latter appearance would not have been recorded, and the conclusion would be: "*Solis Lacus*, exceed- "ingly pale and indefinite."

Fig. 5, 1898, November 3.
(*Molesworth.*)

Fig. 6, 1899, March 1.
(*Phillips.*)

Fig. 7, January 16.
(*Brown.*)

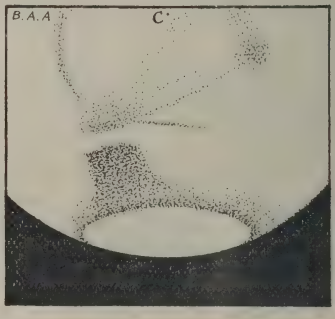

Fig. 8, February 24.
(*Antoniadi.*)

Fig. 9, February 23.
(*Stanley Williams.*)

Fig. 10, January 4.
(*Hall.*)

The *Mare Acidalium* region of Mars in 1898–1899.

of Corder (Plate I., 1), Hall, Kempthorne, Killip, Molesworth, Phillips, A. A. Williams, and Stanley Williams. Among other particularities of this remarkable marking may be mentioned the accurate "bell-shaped" appearance given to it by Hall, and the fact that Stanley Williams saw it "very dark and definite on "the N. and preceding sides, but fainter towards the S. and "following sides," on February 23. When on the left of the

central meridian, Antoniadi found it resembling "a cat seated "on the polar cap." Possibly its darkness was less marked than in 1896–1897, though the change might not be objective, inasmuch as it was just grazing the N. cap three or four years ago —a juxtaposition certainly called to enhance contrast. It is noteworthy, however, that Prof. Schiaparelli's observations from 1883 to 1888 have shown the darkness of *Mare Acidalium* to decrease with the sun's increasing altitude over its horizon.

PYRRHÆ REGIO is well indicated, as a narrow and slightly shaded streak, by Phillips; and Kempthorne saw it united to *Aromatum Promontorium*. It is also vaguely shown by Molesworth.

PROTEI REGIO "seems indicated in several of the drawings" (Molesworth).

ARGYRE is drawn very white on the limb by Molesworth and Antoniadi. Phillips says that "on limb" it was "quite com- "parable to the polar snows in brightness."

MARE ERYTHRÆUM.—The W. part of this vast dusky area was "grey, with a faint indigo tinge," according to Molesworth, while Stanley Williams lays stress on the unevenness in its tint.

NEW LAKE:—

a $\Omega = 20°$, $\Phi = +30°$; detected by Phillips.

This is S.E. of *Mare Acidalium*, and E. of *Niliacus Lacus*; it seems to be different from Molesworth's lake *a* of 1896–97 (last "Report," page 66 and chart, Plate I.), and also different, it would appear, from *Siloe Fons*.

CANALS.

CALLIRRHOE.—Seen by Brown: diffuse.—Molesworth: diffuse (1899, June 10; D = 5″·5).—Antoniadi: merged into the sombre band encircling the N. Cap.

DARDANUS.—Brown: diffuse.—Kempthorne: narrow.—Molesworth diffuse; visible on disc of 5″·6.—Phillips: harsh, marked.—Stanley Williams: faint, narrow.—Antoniadi: sharp and easy.

HYDASPES.—Attkins: narrow.—Antoniadi: easy.

HYDRAOTES.—Brown: narrow.—Kempthorne: edge of shading N.—Molesworth: broad.—Phillips: verry narrow.

"HYPSAS" (Lowell). Shown by Kempthorne: harsh and dark.

IAMUNA.—Attkins: single, narrow.—Brown: single, exceedingly narrow. January 16.—Kempthorne: edge of shading between it and *Lunæ Lacus*. —Killip: diffuse.—Molesworth: diffuse.—Phillips: single; "on March 1, "in good air, it came out as a narrow and well-defined line."—Stanley Williams: "certainly double, both bands faint and diffuse, just like the other "canals, not sharply defined lines," February 23.—Antoniadi: vague and diffuse.

"IAMUNA II" (Molesworth).—Seen by Molesworth in the same position as in 1896–1897. This is the canal A of our last chart.

IAXARTES.—Molesworth: diffuse (1899, June 8; D = 5″·6).

INDUS.—Brown: narrow.—Kempthorne: narrow.—Killip: diffuse.—Molesworth: diffuse.—Phillips: narrow.—Stanley Williams: diffuse.—Antoniadi: diffuse.

IORDANIS.—Molesworth: diffuse (1899, June 7; D = 5″·6).—Phillips: narrow.

NILOKERAS.—Attkins: very dark and triangular in shape, point towards *Lunæ Lacus*, February 24; but narrow the day before.—Brown: diffuse.—Corder: very broad and extended.—Hall: broad and diffuse.—Molesworth: double, *parallel lines*, October 27.—Phillips: anomalously double.—Stanley Williams: "almost certain anomalously double."—Antoniadi: suspected anomalously double.

SECTION III.

Solis Lacus.

$\Omega = 55°$ to $120°$; $\Phi = +60°$ to $-60°$.

LUNÆ LACUS was seen by a considerable number of observers. Attkins draws it (Fig. 15) as a faint, small, round spot. Phillips shows it elongated E. to W., but also small and faint (Fig. 11). On the other hand, Hall (Fig. 12), Kempthorne (Fig. 13), Moles-

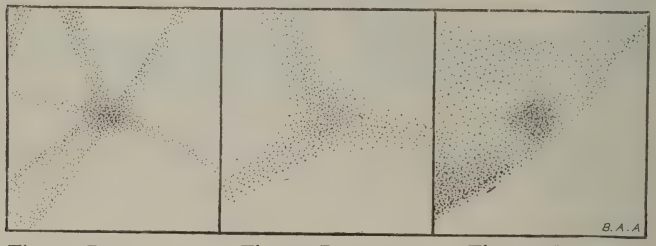

Fig. 11, January 14. (*Phillips.*) Fig. 12, January 14. (*Hall.*) Fig. 13, February 21. (*Kempthorne.*)

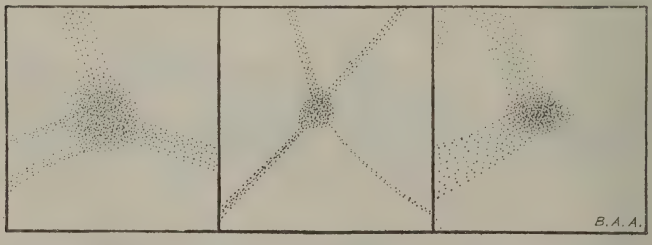

Fig. 14, February 23. (*Stanley Williams.*) Fig. 15, February 23. (*Attkins.*) Fig. 16, February 24. (*Antoniadi.*)

The *Lunæ Lacus* in 1899.

worth, and Stanley Williams (Fig. 14) agree in drawing it very large and diffuse. Antoniadi: "small and dark (Fig. 16); in-" comparably easier than *Solis Lacus*." On February 17, *Lunæ Lacus* was visible when the *Ganges* appeared diffused, but vanished during the geminated view of this canal.

OPHIR is shown white by Attkins when midway between the centre and the limb, while Corder shades all the country from *Ganges* westwards.

TITHONIUS LACUS.—This is drawn as a small, round spot by Attkins on February 23, and described "as a widening of "*Agathodæmon*." Crowley gives it diffuse (Plate I., 5). Molesworth: double in 1898, July; gemination in round spots. Diameter of the disc at the time, 5″·4. This duplication, however, was not confirmed at the subsequent presentations of this region. The lake was seen, eliptical in shape and "fairly dark," by Phillips (Plate I., 6); faint and diffuse by Antoniadi.

SOLIS LACUS was generally a very faint and difficult feature during the past apparition, so that it was sought in vain by most observers. "Careful search," says Attkins, "under good con-"ditions, on seven consecutive nights, failed to show the slightest "trace of the object." It was also unsuccessfully that Crowley looked for it on February 17. Molesworth, however, although remarking that it was "faint throughout," and that it appeared "more distinct near the edge of the disc than when on the "central meridian," drew it nevertheless as far back as 1898, May 31, when the planet's disc subtended 4″·8 only, having, moreover, reobserved it at all subsequent presentations (Plate II., 1). Less fortunate, Phillips and Antoniadi could scarcely make it out when the planet was near opposition, and his diameter subtended 14″·7.

THAUMASIA was found "very white, nearly equal to polar cap," on March 27, by Attkins, while Molesworth records it as being "very dull, especially to S.E."

AUREA CHERSONESUS is not shown by any of the Members of the Section.*

AONIUS SINUS also has not been seen in 1898–99.†

PHŒNICIS LACUS was found "small, round, and distinct throughout," by Molesworth.

DÆDALIA.—Seen white on limb by Attkins.

THARSIS.—Corder shows this part of the planet shaded, the shading beginning from the *Ganges* and *Nilokeras* in order to extend W.

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* In 1894 the Director found this peninsula missing, and the observations from America and elsewhere gave full support to this view. *Solis Lacus* was thus very near the E. coast of *Thaumasia* (*see* 2nd "Report" of this Section by Mr. Cammell, p. 113). But it is interesting to find that M. Brenner drew, at the time, *Aurea Chersonesus* exactly as found on Schiaparelli's early maps!

† The same remarks apply to this marking, which was replaced since 1892 or 1894 by a nearly bright area. And yet M. Brenner shows it in his 1894 map exactly as Schiaparelli in 1877, viz., a sharp, black bay, long penetrating into the continent N.! That prepossession may go so far as to make one see black what is white will be new to many people. Planets should not be drawn "as they ought to be," but as they are.

TEMPE was found "extremely white" when central, on January 14, by Phillips—a phenomenon of condensation of some vapour. *Tempe* is often white. In 1864, Kaiser, in his map of the planet's N. hemisphere, showed four protuberances in the outline of the polar cap, the most remarkable of which, extending down to $\Phi = +36°$, was in *Tempe*. Again, in 1879, a white streak seen crossing the *Nilus* by Schiaparelli, was coming from *Tempe*. Lastly, in 1894, the N. polar cap presented a protuberance in *Tempe*, exactly as drawn by Kaiser 30 years previously. Probably, this region is a tableland on which facilitated radiation of heat into space favours condensation.

MÆOTIS PALUS is shown as a faint protuberance to the band encircling the N. polar cap, by Attkins and Antoniadi.

OGYGIS REGIO was seen united by a bridge to *Aromatum Promontorium* by Kempthorne. Attkins and Phillips show this land white on S. limb.

"DIA." *—A land discovered apparently by Dawes in 1864, and called "*Mist Land*" by Proctor in 1888. On February 14, under $\omega = 91°$, Phillips saw the S. limb bright, doubtless owing to the presence of this island on the central meridian, and the same phenomenon was seen by Antoniadi, under $\omega = 101°$, three days later. This island is too far S. to be shown on the Chart. but it can be seen above *Thaumasia* on our 1896–97 map.

NEW LAKE *b*.—$\Omega = 100°$, $\Phi = +29°$; seen by Molesworth and Phillips somewhere on *Ceraunius*; and an intensification of *Ceraunius* there where it meets Lowell's "*Gigas*"; probably double.

CANALS.

AGATHODÆMON.—Seen by Attkins: very narrow.—Crowley: very diffuse —Molesworth: diffuse.—Phillips: narrow; "not difficult by any means."

CERAUNIUS.—Attkins: single, though "faint and broad."—Molesworth: double, bands diffuse.—Phillips: broad, "seen broad in moments of comparative steadiness."—Antoniadi: anomalously double, as in Schiaparelli's charts; both bands very faint and diffuse. [Intensifications of *Ceraunius* there where it is met by other canals, are shown by Molesworth and Phillips.]

CHRYSORRHOAS.—Attkins: narrow.—Kempthorne: narrow.—Molesworth: diffuse.—Phillips: moderately broad.

CLARIUS.—Attkins, Molesworth, Phillips, and Antoniadi, all agree in showing this canal as part of the polar band.

EOSPHOROS.—Drawn by Molesworth: diffuse.

GANGES.—Attkins: usually narrow, but "very broad," February 17.—Corder: very diffuse.—Hall: very diffuse.—Kempthorne: not indicated; a vague shading covering the triangular region *Ganges—Iamuna—Nilokeras*.—Molesworth: double, 1898, April 27, with a disc of Mars not greater than 4″·6; sharply double, October 27.—Phillips: broad; "less prominent than in 1896–97."—Stanley Williams: "broad, but faint and diffuse."—Antoniadi:

* Name given by the Director. Δία was the old name of Naxos; also that of an island a few miles N. of Crete.

usually broad and diffuse; but on February 17^{d} 8^{h} 23^{m} distinctly double (Fig. 17) with *Nilus*. (*See* "Journal," Vol. IX., p. 371.) The appearance lasted for about one third of a second. The planet's limb appeared, mean-

Fig. 17. Gemination of the *Ganges* and *Nilus*, as seen for one third of a second, on 1899, February 17 (*Antoniadi.*)

time diffuse. But this does not invalidate the idea of objective gemination, inasmuch as the eye cannot, at a given moment, see distinctly over more than a very small fraction of the planet's disc. It will be seen that in this case the broad and diffuse appearance given to the *Ganges* by other observers corresponds very satisfactorily to an imperfect view of the two lines, the distance separating which is practically equal to the breadth of the broad band. If we consider, moreover, that Capt. Molesworth and Signor Cerulli have also seen the *Ganges* doubled, we think that there can be little doubt of the objective reality of this gemination, and that the fugitive appearance seen on February 17, was, as suspected at the time by the Director, a neater perception of the amorphous *Ganges* seen under unfavourable definition.

Attkins saw an indentation in *Auroræ Sinus* at the estuary of the *Ganges*.

FORTUNA.—Molesworth and Phillips: diffuse.

IRIS.—Seen by Phillips: diffuse.

ISSEDON was seen by Molesworth diffuse, when the planet's disc measured 5″·7.

NECTAR.—Molesworth: diffuse; "usually fairly easy." There is a prolongation of *Nectar* into the *Mare Erythræum*.—Phillips: diffuse.

NILUS.—Attkins: narrow and faint.—Hall: broad and diffuse.—Molesworth: diffuse.—Phillips: "not difficult . . . seen to terminate in a dusky spot on *Ceraunius*. It was less broad than the *Ganges*, but was *not* seen as a narrow, sharply defined line."—Stanley Williams: "broad, very faint, diffuse."—Antoniadi: distinctly double on February 17. The breadth separating the two streaks was equal to that of the faint line seen by Stanley Williams. Hence the probable objectivity of this doubling also.

PHASIS.—Crowley: indefinite.—Molesworth: diffuse.

PHLEGETHON.—Molesworth: diffuse; seen on 1899, July 6, on a disc of 5″·0.—Phillips: faint and moderately narrow.—Antoniadi: easy; dark and narrow streak, on January 8.

TANAIS.—Seen by Attkins, Brown, Molesworth, Phillips, Stanley Williams, and Antoniadi, as part of the dark boundary of the N. cap.

URANIUS.—Seen by Kempthorne: narrow.

NEW CANAL, **A**.—From $\Omega = 42°$, $\Phi = +43°$, to $\Omega = 98°$, $\Phi = +30°$. Detected by Molesworth.

SECTION IV.

Mare Sirenum.

$\Omega = 120°$ to $180°$; $\Phi = +60°$ to $-60°$.

ICARIA.—Owing to the invisibility of *Aonius Sinus* (p. 85) this land was not defined to the S.E. On the other side, however, to the N.W., along *Mare Sirenum*, the coast did not seem to have undergone any appreciable change since former years. Attkins, Molesworth, Phillips, and Antoniadi agree on this point. Attkins saw *Icaria* white near the limb.

PHAETHONTIS is described as a "brilliant white spot on limb," March 14, by Attkins. Phillips says that it was "very brilliant, appearing at times to indent the *Mare Sirenum*." A. A. Williams and Antoniadi also show it white near the limb.

MARE SIRENUM.—Attkins, Crowley, Molesworth, and Phillips (Plate II., 3) give to this marking its usual Schiaparelli outline. Attkins shows it fairly dark, and so also Kempthorne, particularly towards *Titanum Sinus*. "The beak of the *Sirens*," says Molesworth, "remained fairly dark throughout." (Plate II., 2.) The same observer noted, on 1898, October 17, "a delicate blue grey, the blue tinge being most obvious at *Titanum Sinus*." Phillips found this *Mare* rather faint, probably fainter than in 1896–97. The estuary of the canal *Gorgon* was seen as a dark knot by Molesworth.

ATLANTIS I. is shown as a bright bridge by Attkins ("plain"), Brown (marked near limb), Kempthorne (very marked indeed), Molesworth ("fairly distinct at times, most distinct near terminator"), Phillips ("distinctly seen in moments of best image"); and Antoniadi (slightly shaded).

ATLANTIS II.—Not shown by any of the Members of the Section.

MEMNONIA was seen white near the limb by Attkins.

AMAZONIS.—"Duller than *Memnonia* or *Zephyria*" (Molesworth).

ARCADIA does not seem to have shown any shading in 1898–99.

NODUS GORDII is drawn as a large, faint, round marking by Attkins. Hall shows it very diffuse, very faint, and very extended. Molesworth: "diffuse, but having, when the defini- "tion was first-class, a streaky aspect, as if including numerous "faint canals." Phillips shows it also exceedingly diffuse.

"NODUS GORDII" (Lowell*).—This small "bead" on *Eumenides-Orcus* was seen by Molesworth.

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* For the differentiation between the two *Nodi*, *see ante*, p. 72.

"LUCUS MARICÆ" (Lowell). — Seen by Molesworth and Phillips.

"AMMONIUM" (Lowell).—Seen by Molesworth and Phillips.

"CASTALIA FONS" (Lowell).—Seen by Molesworth.

PROPONTIS.—This large lake is shown on the drawings of a considerable number of Members of the Section. Hall draws it very accurately, and not quite separated from the polar "marshes." It is dark on Kempthorne's drawing. Killip shows it vaguely.

Fig. 18, 1898, Oct. 17. (*Molesworth.*)

Fig. 19, 1899, Feb. 1. (*Phillips.*)

Recent views of the *Propontis* region of Mars.

Antoniadi found it vague and diffuse. Molesworth and Phillips depict *Propontis* so beautifully that we subjoin their whole disc drawings of these regions (Figs. 18 and 19). "This lake," says Phillips, "was quite dark, even when close to the terminator."

NEW LAKES:—

c $\Omega = 122°, \Phi = -\ 9°$; detected by Molesworth.
d $\Omega = 167°, \Phi = +\ 28°$; detected by Molesworth.

CANALS.

"BRONTES" (Lowell).—Seen by Molesworth, diffuse.

"ELISON" (Lowell).—Seen by Molesworth, diffuse.

EUMENIDES-ORCUS.—Attkins: narrow.—Corder: very diffuse.—Hall: diffuse.—Kempthorne: narrow.—Molesworth: diffuse, broad; S. edge distinct; N. diffuse. Inasmuch as this observer notes *Amazonis* duller than *Memnonia*, the canal *Eumenides-Orcus* becomes the edge of a shade.—Phillips: "not so dark as during last apparition" (Dec. 31)—"*Orcus* seen "as a faint, broad streak, but no lakes on it" (January 4). "Seemed darker than of late," (February 21). "On one occasion," says Phillips, "the *Eumenides-Orcus* was for a moment or two doubled, together with the "*Trivium Charontis*. The effect, however, was very transitory, and was "evidently an optical illusion caused, perhaps, by the passing of air-waves "or by a temporary alteration of the focus of the eye."—Stanley Williams: "seemed single."—Antoniadi: broad and indefinite.

EUROTAS.—Seen by Molesworth, diffuse.

FEVOS.—Seen by Molesworth, diffuse.

GIGAS.—Hall: very indefinite.—Molesworth: directed on drawings more N., possibly Lowell's "*Gigas*" and not Schiaparelli's. The change of direction is a frequent phenomenon with canals, according to Schiaparelli.

GORGON.—Molesworth: diffuse.—Antoniadi: confuse; at one time a very hazy impression of doubling; doubtful.

HEBRUS.—Seen by Molesworth, diffuse.

PYRIPHLEGETHON.—Attkins: narrow.—Killip: harsh; moderately broad.—Molesworth: diffuse.—Phillips: diffuse.

SIRENIUS.—Attkins: narrow.—Killip: harsh; moderately broad.—Molesworth: diffuse.—Phillips: very broad to N.

TITAN.—Hall: diffuse.—Molesworth: diffuse.—Phillips: diffuse.

NEW CANAL B.—From $\Omega = 106°$, $\Phi = +30°$ to $\Omega = 150°$, $\Phi = +20°$; detected by Molesworth.

SECTION V.

Mare Cimmerium, Elysium, and Trivium Charontis.

$\Omega = 180°$ to $250°$; $\Phi = +60°$ to $-60°$.

MARE CIMMERIUM.—This long sea was seen by most Members with its customary outline, and the descriptions of its intensity are fairly accordant: *Mare Cimmerium* was moderately dark in 1898–99. Attkins, Brown, Corder, Crowley, Hall, A. A. Williams and Antoniadi confirm each other here. However, Killip, Mee, and Phillips depict this area a little darker and narrower than on Schiaparelli's maps. Phillips adds: "strange to say, the *Mare* "*Cimmerium* has appeared to me considerably darker than *Mare* "*Sirenum*. Exactly the reverse was the case last apparition." Kempthorne shows it a little darker still, while Molesworth found the colour of the *Mare* "dark bluish grey. Only traces of "*Cimmeria* have been seen between *Sinus Læstrygonum* and "*Cyclops*."

HESPERIA is drawn exceedingly narrow by Attkins, who describes it "distinct." Corder saw it very bright, but apparently severed from the land to the N. Hall: "so faint as to be doubtful," February 2. Kempthorne shows it shaded, February 3. Mee depicts it distinctly white, and, like Corder, severed from the mainland (*Triton*). Molesworth remarked that the N. portion of this peninsula was shaded. Phillips: "well seen," December 23, "*Hesperia* narrow, but very distinct," but on March 7 "no trace of *Hesperia*, though carefully looked for." The peninsula is further distinctly drawn by A. A. Williams (Plate III., 2). Antoniadi found nothing abnormal in these regions. The plurality of inclined peninsulæ or islands bending round at right angles to join the mainland to the N. is a striking feature of the planet's S. hemisphere. *Pyrrhæ Regio*, *Deucalionis Regio*, *Œnotria*, *Hesperia* and, perhaps, *Atlantis*, all present more than one point of similitude.

TYRRHENUM MARE (E.).—Attkins depicts this sea of the same tone as the *Mare Cimmerium*; Corder, less dark. So also

Molesworth, A. A. Williams, and Antoniadi; Mee and Phillips show it very dark; Kempthorne, still darker.

ELECTRIS has been drawn white on the limb by Molesworth, Phillips, and Antoniadi. Phillips says that it was "very white at the terminator;" also very white on S. limb, December 31.

ERIDANIA is described "as white as polar cap," March 14, by Attkins. Molesworth also shows it white. Phillips notes it "very white at the terminator." *Eridania* was invariably bright on the limb to Antoniadi.

ZEPHYRIA is shown white at the edge of the disc by Attkins and Phillips.

ÆOLIS was seen white near the limb by Attkins.

ÆTHIOPIS is represented slightly shaded by Kempthorne.

"PAMBOTIS LACUS" (Cerulli), on the rendezvous of *Cyclops*, *Cerberus*, *Antæus*, *Pactolus*, and *Eunostos* was admirably seen by Brown and Molesworth.

ELYSIUM appears to be the brightest continental area of the planet; its brightness being not only remarkable when rising or setting at the edge of the disc, but remaining considerable even when the rotation of Mars brings it over the central meridian. The correct polygonal outline of this marking is shown by almost all the Members:—Attkins, Brown, Corder, Hall, Kempthorne, Mee, Molesworth, Phillips, Stanley Williams, and Antoniadi. The latter found the canals bounding this area sharp inside, diffuse outside. As in 1896–97, the brightest part of *Elysium* was its E. angle. At this point an intensely white spot was drawn by Attkins, Brown, Kempthorne, Molesworth, Phillips, and Antoniadi. Phillips, moreover, draws all the E. half of *Elysium* brighter than the W. half; the line of demarcation between the two tints being the *Galaxias*. Brown confirms this; but, inasmuch, as he sees the polygon cut into three (Plate II., 6) by the new canal C as well as by the curved line discovered in 1896 by Molesworth, his W. boundary of the bright area is different from that of Phillips. Molesworth gives a smaller surface to the bright patch; he again saw *Elysium* broken up by his 1896 canal (E on our last chart), and seems to have also detected part of *Galaxias*. The brightness of Elysium would seem to have decreased with the shrinking of the disc. On March 10, Attkins found the white spot invisible, a statement which received full corroboration at the hands of Phillips and Antoniadi. The change, however, might not necessarily be objective, the increasing distance of Mars having, perhaps, something to do with it.

TRIVIUM CHARONTIS.—This remarkable dark spot was described by Attkins as "oblong in shape, running, roughly, N. and S. (Plate II., 5); darker than seas; *f* side very dark and definite, *p* indefinite," and, lastly, "crescentic" on March 14. On March 15, the same observer found that "*Trivium Charontis* seemed to be nearly "divided by the white spot following it." Brown notes that the lake seemed composed of "two very dark markings," which he could not see round. Corder and Crowley show the spot very diffuse, and in this they are confirmed by Hall,

who, however, draws it darker at the S.W. end. Kempthorne shows it as a black equilateral triangle, one point of which is directed towards the *Orcus*, the other towards the *Cerberus*, and the last one along the *Styx*. Stanley Williams corroborates this statement: "*Trivium Charontis* itself," he says, "is not double "at the present time, but seems of a triangular shape, with "lighter interior, as though it were formed by several crossing or "interlacing canals, as represented in the diagram." (Fig. 20.)*

Fig. 20.—The *Trivium Charontis* in March 1899.
(*Stanley Williams.*)

Molesworth, Phillips, and Antoniadi show the lake dark in the centre, but with diffused edges, whilst A. A. Williams gives it a remarkable extension.

HEPHÆSTUS is shown as a very faint and diffuse marking by Brown, Hall, Molesworth, and Phillips. The latter depicts it as the S.E. boundary of the great shading near *Boreosyrtis*.

HECATES LACUS.—A dark spot on the N.E. angle of *Elysium*, at the meeting point of *Styx*, *Chaos*, *Plutus*, *Boreas*, and *Æsacus*; seen by Brown (very dark), Molesworth, Phillips (very dark), and Antoniadi.

STYMPHALIUS LACUS.—This is the name given by Schiaparelli, in 1888, to the dusky area at the rendezvous of *Æsacus*, *Granicus*, *Choaspes*, *Adonis*, and *Gyndes*. The marking is shown by Brown and Phillips ("large dark lake between *Styx* and *Hades*," December 29).

PHLEGRA.—Shown shaded by Corder, Kempthorne, Molesworth, Phillips (Plate II., 4), and Antoniadi.

CEBRENIA.—Shaded: Corder, Mee, Molesworth, Phillips, and Antoniadi.

ÆTHERIA. — Shaded: Corder, Kempthorne, Molesworth, Phillips, and Antoniadi.

It would appear that the shading of these regions was an extension of the great *Boreosyrtis* intensification, dealt with in the next Section.

NEW LAKES:—

e $\Omega = 217^\circ$, $\Phi = +39^\circ$; detected by Brown.
f $\Omega = 225^\circ$, $\Phi = +39^\circ$; detected by Brown.

* Mr. Stanley Williams remarks that "an intensification of two such spots "at the N. and S. angles of the triangle might cause the *Trivium Charontis* "to appear under the form of two round black spots," as seen in 1896.

CANALS.

ADAMAS.—This is the name given by Schiaparelli to a double canal observed by him in 1888 uniting *Boreosyrtis* to *Hephæstus*. The same canal, but single, and continued to *Mare Cimmerium* ("*Pseudoæthiops*" of Signor Cerulli), was observed by the following Members of the Section in 1898–99 :—Kempthorne : single, narrow, "clear and sharp."—Molesworth : single, diffuse (not following the same course as Kempthorne's line).—Antoniadi : single, easy, and narrow.

ÆSACUS. — Brown : diffuse. — Molesworth : seen on 1899, June 26; D = 5″·2.—Antoniadi : diffuse.

ÆTHIOPS.—Seen by Molesworth only : diffuse.

ANTÆUS.—Seen by Kempthorne : narrow.—Molesworth : diffuse.

BOREAS.—Seen by Molesworth only : diffuse.

CERBERUS.—Attkins : rather narrow.—Brown : broad and marked.—Corder : diffuse.—Hall : faint, diffuse.—Kempthorne : rather narrow.—Killip : broad, harsh.—Mee : diffuse.—Molesworth : double, on 1898, November 17 ; gemination extending to *Cyclops*, after which the canal is single to *Mare Cimmerium*.—Phillips : exceedingly broad ; "surely it is a quite "misnomer to speak of the *Cerberus* as a '*canal*.' I think it would be more "correct to term it a '*sea*,' if, indeed, the broad dark areas are aquatic "at all."—Stanley Williams : double. On March 15, "definition was pretty "good at times, and the canal appeared most distinctly double with 450. "Owing to the small size of the image (apparent diameter of planet = 10″), "the duplicity was only suspected with 320, but with the higher power "it was undoubted. The canal, in fact, was seen double with as much "certainty and distinctness as a double star near the limit of separation for "the aperture employed."—Antoniadi : very broad and dark; as dark, indeed, as *Mare Cimmerium*.

CHAOS.—Brown : diffuse.—Corder : diffuse.—Hall : indefinite.—Molesworth : diffuse.—Phillips : dark and broad.—Antoniadi : very marked.

CYCLOPS. — Attkins : narrow. — Brown : very narrow. — Corder : very broad.—Kempthorne : edge of shading on Æthiopis.—Molesworth : at first diffuse, but then double, 1898, November 17.—Phillips : "broad"; inclined to meridian; trend from N.N.E. to S.S.W., February 1.—Stanley Williams : diffuse.—Antoniadi : very faint, difficult, and diffuse.

EREBUS.—Attkins : narrow.—Molesworth : diffuse.—Phillips : faint.

EUNOSTOS. — Attkins : narrow. — Brown : narrow; then, possibly, anomalously double?—Corder : diffuse.—Kempthorne : broad, diffused.—Mee : diffuse.—Molesworth : diffuse.—Phillips : moderately broad.—Stanley Williams : broad.—Antoniadi : diffuse, but very easy.

GALAXIAS.—Brown : narrow.—Phillips : extremely narrow.

GRANICUS.*—Seen by Brown : diffuse.

GYNDES.—Seen by Brown : diffuse.

HADES.—Hall : faint, diffuse.—Kempthorne : broad; edge of shading between it and *Styx*.—Killip : harsh and broad.—Molesworth : diffuse; edge of shading between it and *Styx*.—Phillips : dark ; edge of shading between it and *Styx*.—Stanley Williams : well marked; "suspected double."—Antoniadi : diffuse; edge of shading between it and *Styx*.

HYBLÆUS.—Brown : broad.—Corder : diffuse.—Molesworth : diffuse.—Phillips : moderately broad.—Antoniadi : obvious, but diffuse.

"HYBLÆUS II." (Molesworth).—Seen by Brown and Molesworth in about the same position as drawn by the latter in 1896–97. This is the canal **E.** of our last chart. Diffuse and curved.

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* Prof. Schiaparelli draws attention to the fact that in his map, published in 1889 in "Himmel und Erde" (Flammarion, "Mars," p. 440), the *Granicus* is erroneously called *Gyndes*, and that the name for the true *Gyndes* is missing. The *Granicus* unites *Propontis* to *Stymphalius Lacus* ; the *Gyndes*, *Stymphalius Lacus* to *Sithonius Lacus*.

LÆSTRYGON. — Brown : narrow. — Kempthorne : narrow. — Molesworth : diffuse.— Phillips : narrow.—Antoniadi : narrow and difficult.

PACTOLUS.—Seen by Brown : narrow.—Molesworth : diffuse.

PLUTUS.—Brown : diffuse.—Molesworth : diffuse ; seen on a disc of 5″·2. The angular breadth of the canal ought not thus to have exceeded $\frac{1}{10}$″.

STYX.—Brown : dark and very broad.—Corder : exceedingly broad, melting into shading towards *Hades*.—Kempthorne : broad ; edge of shading between it and *Hades*.—Killip : broad.—Mee : diffuse.—Molesworth : double ; 1898, November 9, space between it and *Hades* shaded.—Phillips : almost black ; space between it and *Hades* shaded.—Stanley Williams : broad to N., narrow to S. ; this makes it triangular in appearance.—Antoniadi : very dark and broad ; double (?) February 4 ; edge of shading between it and *Hades*.

TARTARUS. — Kempthorne : narrow. — Molesworth : diffuse. — Stanley Williams : diffuse.—Antoniadi : very faint and diffuse.

TRITON.—Corder : broad and black.—Mee : harsh and black.—Molesworth : diffuse.

XANTHUS.—Drawn by Molesworth early in 1898, when the planet showed us its S. pole.

NEW CANAL, C.—From $\Omega = 220°$, $\Phi = +19°$, to $\Omega = 232°$, $\Phi = +14°$. Detected by Brown.

SECTION VI.

Syrtis Major.

$\Omega = 250°$ to $310°$; $\Phi = +60°$ to $-60°$.

TYRRHENUM MARE (W.).—This, the W. portion of *Mare Tyrrhenum*, was much darker than the E. portion. It has been seen quite dark up to the limb.

SYRTIS PARVA did not present any remarkable features. It was not a very dark marking. Kempthorne shows it of the same tint as *Maria Cimmerium* and *Tyrrhenum*, and somewhat harshly marked. Mee, Molesworth, and Phillips corroborate this view. On the other hand, however, Brown, Corder, Hall, A. A. Williams, and Antoniadi agree in showing it a little fainter and somewhat more confused.

AUSONIA.—Seen white near S. limb by Hall, Mee, Phillips, and Antoniadi. The whitening does not seem to have been very intense. Townshend saw, in addition, a bluish tinge to the white colour of this ill-defined land.

HADRIACUM MARE is shown dark by Attkins, and very dark by Corder. Molesworth also draws it very dark, and with a darker knot on the W. coast of *Hellas*, somewhere about the *f* embouchure of *Peneus*. Phillips and Antoniadi draw it fainter. Only the lower half of the boundary of *Hellas* was well seen in 1898–99.

HELLAS.—Owing to the tilt of the axis, this land was never orange red when on the central meridian. On March 9, Attkins found it "nearly as white as polar cap."* Also, Hall, Mee,

* *Hellas* has often been mistaken for a polar cap. Thus, on 1777, April 17, Sir William Herschel drew two caps, one N. the other S., the line uniting which, however, did not pass through the centre of the planet's disc (Flammarion, "Mars," p. 51, Fig. 17 of Herschel's series). The longitude of the centre was 324° and its latitude positive. Hence there can be no doubt that "cap *a*" was not a true cap, but white *Hellas* on S. limb.

Molesworth, Phillips. Townshend (Plate III., 3), and Antoniadi insist on its remarkable brightness.

"LUNÆ PONS" (Lowell) is represented by Attkins ("very distinct"), Brown, Hall (Plate III., 1), Phillips, Molesworth, and Antoniadi.

"SOLIS PONS" (Lowell) is shown by Attkins, Hall, Molesworth, Phillips, and Antoniadi.

IAPYGIA is indicated by Brown; it was seen by Hall, and described "very distinct" by Phillips.

ŒNOTRIA.—An easier marking than the preceding. Attkins shows it disfiguring *Syrtis Major* by transforming into a "shoal" a considerable part of its W. half; the shoal seeming bounded to E. by a strong black line.* Brown and A. A. Williams depict it as a slight fading of the *Syrtis*. Kempthorne gives it an E. extension—almost near *Mœris Lacus*, while Molesworth, Phillips, and Antoniadi saw it as given in Schiaparelli's charts.

SYRTIS MAIOR.—No important change in the general outline of this grand object since 1896–97. As at the last apparition, the *Syrtis* showed very decidedly the form given to it by Lowell in 1894, with a sharp point to the N. The numerous drawings by Attkins, Brown, Corder, Hall, Kempthorne, Killip, Mee, Phillips, Townshend, A. A. Williams, and Antoniadi are all in excellent agreement as to this. But Molesworth shows the N. end distinctly blunted, as on the annexed diagram (Fig. 21). A very large

Fig. 21. The *Syrtis Major* region on 1898, November 11. (*Molesworth.*)

* Probably Lowell's "*Dosaron.*" This canal in a dark area is shown on Prof. Schiaparelli's drawings in 1888.

majority of the drawings sent show further the N. end as the darkest part of the *Syrtis*. The colouring of this immense dark area did not seem uniform. Allusion has already been made to Attkins's remarkable observation of what seems to be Lowell's "*Dosaron*," vague traces of which are found on the Ceylon drawings, but in his description of Fig. 21, Molesworth draws attention to the "much veined" appearance of *Syrtis Major*, which was "very dark and distinct, with darker nuclei at the "estuaries of *Typhon*, *Thoth*, *Astapus*, and *Astusapes*," Colour: "a distinctly greenish grey" (Molesworth). According to the same observer, the "following side of *Syrtis Major* was very dark —more so than the preceding side." Townshend lays stress on the fact that the duplication of the N. point observed by him in 1896–97 (*vide* last "Report," p. 94) had been confirmed by M. Comas Sola in Spain. On one of his drawings A. A. Williams unites *Libya* to *Hammonis Cornu* by a straight bridge, parallel to the Martian equator, and recalling to memory a drawing taken by Mr. Gledhill on 1871, April 4 (Flammarion, "Mars," p. 208, Fig. 129), and Lohse, 1873, May 25 (*Ibid.*, p. 227, Fig. 146).

As in 1896–97, Phillips was fortunate in detecting a bright bridge in $\Phi = +22^{\circ}$ completely separating the *Syrtis Major* from the *Nilosyrtis* (Fig. 22). "I have noticed this," he says, "distinctly on several occasions when the air had been good enough, "and feel quite convinced of its objective existence." Attkins fully endorsed this statement when saying that on March 10,

Fig. 22. Bridge severing the *Syrtis Major* from the *Nilosyrtis*. 1899, January 30. (*Phillips*).

" at times it appeared that *Syrtis Major* was separated from " *Nilosyrtis* by a whitish marking—probably owing to irradiation " from a whitish, round spot following N. end of *Syrtis Major*" —an observation which he repeated on April 11.* This occasional bridging of the *Maria* is not a rare occurrence on Mars. In 1890 it was *Solis Lacus* which was thus cut in two, in 1892 *Mare Sirenum* (near the " beak "), according to Schiaparelli; while the narrow white marking seen by the Flagstaff observers in 1894 to issue from *Fastigium Aryn* southwards, across *Dawes's Forked Bay*, probably belongs to the same class of phenomena.

MŒRIS LACUS is shown as a mere bight of the *Syrtis Major* by Attkins, Brown, Mee (Plate III., 4), Molesworth (" still merged in the eastern coast of the *Syrtis Major*"), Phillips, Stanley Williams, and Antoniadi. On February 1, however, Phillips saw a faint lake a short distance inland, E. of *Mœris*, while Stanley Williams notes that " *Lacus Mœris* appeared as a round, " very dark, in fact, almost black-looking spot, open on the " following side to the *Syrtis Major*, though once or twice a " narrow bright border separating it from the latter was " suspected."†

LIBYA.—Observed bright by all the Members of the Section, and further brightening near the terminator or limb. Comparing the observations of 1888 or 1890 with those of 1898–99, it will be found, in spite of some recent statements to the contrary, that the evidence of objective change is overwhelming, and that the results are here far outside the errors of observation.

NIX ATLANTICA.—On a drawing dated 1898, November 9, $\omega = 276°$, $\phi = +16°$, Molesworth depicts a small, bright round spot very near the position of the celebrated *Nix Atlantica*, seen by Prof. Schiaparelli from 1877 to 1882. In his description of this marking, the observer simply notes " a small circular bright " spot, apparently just N. of the estuary of Thoth." But there can be little doubt of its identity with *Nix Atlantica*. " If its appearance," wrote Schiaparelli in 1888 (Flammarion, " Mars," p. 441), depend on the period of the Martian seasons, we ought to expect to re-observe it during the oppositions of 1892 to 1897, and it is easy to appreciate of what importance will be its return for the study of the physical constitution of the planet."

NEITH REGIO is shown slightly shaded between the canals *Nilosyrtis* and " *Nasamon*," by Attkins, Corder, Phillips, A. A. Williams, and Antoniadi. This completes the " hour-glass " form of *Syrtis Major*. A bright spot was seen by Kempthorne in *Neith Regio* towards $\Omega = 268°$, $\Phi = +34°$.

COLOE PALUS is well depicted by Brown, as a very small black spot, January 26. Kempthorne, Molesworth, Phillips, and Antoniadi, give it a more diffused appearance.

UTOPIA.—This bright continental area was transformed, in 1898–99, into a very dark, almost black, marking, the blackness

* Signor Cerulli further confirms the reality of this marking in his 1898–99 map.

† The laky character of *Mœris* is clearly shown by Cerulli.

remaining unchanged even when rotation brought it on the limb. Attkins, Corder, Hall, Kempthorne, Mee, Molesworth, Phillips, and Antoniadi, thus show the country marked by an extraordinary mass of dark material. The latter would seem to be furnished by the intensification of the great canal *Boreosyrtis*, and it is probable that the partial concomitant shading of *Ætheria*, *Cebrenia*, and *Phlegra*, described in Section V., was due to the same cause. In this case also, the evidence in favour of objective change since 1888 is very strong.*

NEW LAKES:—

g $\Omega = 262°$, $\Phi = +34°$; detected independently by Brown and Kempthorne.

h $\Omega = 280°$, $\Phi = +54°$; detected by Phillips in 1896–97 (when the canal *Boreosyrtis* was seen "swollen into a lake-like aspect," *vide* last Report, p. 94); and re-observed now by Attkins, Brown, Corder, Hall, Kempthorne, Mee, Molesworth, Phillips, and Antoniadi.

CANALS.

ALCYONIUS.—Seen by Molesworth on 1899, June 21, D = 5″·2.

AMENTHES.—Attkins: very narrow.—Brown: faint.—Kempthorne: very narrow; edge of shading in *Æthiopis*.—Mee: diffuse.—Molesworth: diffuse.—Phillips: moderately broad.—Stanley Williams: faint.—Antoniadi: very easy, though broad and diffuse.

ANUBIS.—Seen by Molesworth diffuse.

ASCLEPIUS.—Mee: in part only.—Molesworth: diffuse.—Antoniadi: faint and diffuse.

ASTABORAS.—Molesworth: diffuse.—Phillips: narrow.

ASTAPUS.—Brown: narrow.—Kempthorne: very narrow.—Molesworth: diffuse.

ASTUSAPES.—Brown: narrow.—Molesworth: diffuse.—Phillips: very narrow.

ATHYR.—Seen by Molesworth diffuse.

"AXON" (Cerulli).—Molesworth: diffuse and extending E. and W. of Cerulli's "*Nuba*."—Antoniadi: diffuse and broad.

BOREOSYRTIS.—Attkins: very dark; darker than *Mare Cimmerium*, March 14, W. limit of shade in *Utopia*.—Brown: broad.—Corder: diffuse.—Hall: dark and broad.—Kempthorne: extremely dark and definite; W. end of *Utopia* shade.—Mee: very dark; W. limit of *Utopia* shade.—Molesworth: very dark.—Phillips: exceedingly dark; W. limit of shade in *Utopia*.—Antoniadi: dark and broad; W. limit of shade in *Utopia*.

EURIPUS.—Seen by Molesworth diffuse.

HELICONIUS.—Seen by Molesworth; diffuse on a disc of 5″·2.

LETHES.—Seen by Antoniadi very faint.

"NASAMON."†—Attkins: narrow.—Hall: diffuse.—Molesworth: diffuse.—Phillips: faint; edge of shading in *Neith Regio*.—Townshend: diffuse.—

* The darkness of the *Boreosyrtis* region has been detected long ago. It is shown on drawings by Hooke, 1666; W. Herschel, 1777; De la Rue, 1856; Secchi, 1858; Burton, 1871; Flammarion, Green, Lohse, Schmidt, and Terby, 1873; Burton, 1882; Knobel and Lohse, 1884; Denning, 1886; Perrotin and Wislicenus, 1888, &c. It is, meantime, interesting to point out that whereas the last two observers were seeing shaded the region in question in 1888, Schiaparelli did not see any shading at all.

† *See* p. 70.

A. A. Williams: diffuse; edge of shading in *Neith Regio*.—Antoniadi: diffuse; edge of shading in *Neith Regio*.

NEPENTHES.—Kempthorne: "very faint"; narrow.—Molesworth: almost straight from *Mœris Lacus* to *Hephæstus*; diffuse.—Phillips: narrow.—Antoniadi: faint, not in its Schiaparellian course.

NILOSYRTIS. — Attkins: narrow. — Brown: narrow, dark. — Corder: diffuse.—Kempthorne: very narrow, gracefully curved.—Killip: narrow.—Molesworth: narrow.—Phillips: narrow and dark; edge of shade in *Neith Regio*.—A. A. Williams: diffuse, edge of shade in *Neith Regio*.—Stanley Williams: "remarkable for its faintness in March."—Antoniadi: difficult. Certainly not the easiest of canals in 1898–99.

"RHESUS" (Cerulli).—Seen by Molesworth di use.

THOTH.—Brown: faint.—Antoniadi: indefinite.

SECTION VII.

The South Polar Region.

$\Omega = 0^\circ$ to 360°; $\Phi = -60^\circ$ to -90°.

Mars was too far from the earth when the south polar cap was visible, early in 1898. Hence, no returns of the diminution of the white material came to hand, with the exception of the following Table, due to Molesworth, and in which ω is the longitude of the centre of the disc during observation, α the areocentric arc subtended by the cap, and d the number of days separating the determination from the summer solstice of the S. hemisphere (— before, + after):—

Date.	ω	α	d.	Date.	ω	α	d.
1898.	°	°		1898.	°	°	
April 25 -	86	42	−36	June 8 -	357	17	+ 8
„ 27 -	63	42	−34	„ 9 -	348	17	+ 9
May 1 -	27	41	−30	„ 11 -	332	13	+11
„ 3 -	4	38	−28	„ 17 -	270	11	+17
„ 7 -	325	34	−24	„ 18 -	263	11	+18
„ 8 -	317	32	−23	„ 21	233	invis.	+21
„ 11 -	289	28	−20	„ 25 -	194	invis.	+25
„ 12 -	272	29	−19	„ 26 -	187	10	+26
„ 13 -	265	28	−18	„ 27 -	170	9	+27
„ 16 -	232	26	−15	„ 29 -	151	11	+29
„ 18 -	216	27	−13	„ 30 -	148	9	+30
„ 20 -	196	26	−11	July 1 -	131	10	+31
„ 21 -	184	26	−10	„ 2 -	118	7	+32
„ 23 -	164	24	− 8	„ 3 -	118	invis.	+33
„ 24 -	149	24	− 7	„ 4 -	105	invis.	+34
„ 25 -	143	22	− 6	„ 6 -	85	8	+36
„ 31 -	80	20	0	„ 7 -	71	9	+37
June 1 -	72	19	+ 1	„ 9	54	6	+39
„ 2 -	60	20	+ 2	„ 10 -	44	invis.	+40
„ 4 -	37	20	+ 4	„ 11 -	38	9	+41
„ 5 -	38	17	+ 5	„ 12 -	28	invis.	+42

After July 11, the S. cap was seen no more in Ceylon. Soon after its disappearance, whitish glimmers were visible in the S. polar regions, as in 1896–97.

SECTION VIII.

The North Polar Region.

$\Omega = 0^\circ$ to 360°; $\Phi = +60^\circ$ to $+90^\circ$.

"Throughout August and September, the N. polar region was "generally a dull white, with none of the characteristics of a true "polar cap. . . . . Towards the middle of September this "became a dull, not very white, patch, bounded, as a rule, by a "very faint streak of shade, diffuse towards the S. It was not "till September 28, that the cap was really well seen, shining "with a pale, almost greenish lustre, brightest to E., the bounding "marsh being distinct and dark" (Molesworth). Traces of the cap were also caught by Phillips on 1898, September 16, and by Stanley Williams a week later.

The change in the area of the white material went on as follows:—

d is here the number of days before (−) or after (+), the summer solstice of N. hemisphere.

Date.	ω	a	d	Observer.	Date.	ω	a	d	Observer.
1898.	°				1898.				
Sept. 16	197	50	−250	Phillips.	Nov. 18	217	56	−187	Antoniadi.
„ 24	95	8 P	−242	Stanley Williams.	„ 19	{196 / 219}	56	−186	Molesworth.
„ 28	{340 / 352}	43	−238	Molesworth.	„ 21	194	65	−184	Phillips.
„ 30	324	43	−236	Molesworth.	Dec. 7	52	54	−168	Phillips.
Oct. 1	{309 / 321}	52	−235	Molesworth.	„ 17	309	55	−158	Phillips.
„ 2	{298 / 308}	61	−234	Molesworth.	„ 20	{269 / 284}	42	−155	Antoniadi.
„ 6	{262 / 272}	54	−230	Molesworth.	„ 20	276	50	−155	Phillips.
„ 9	{235 / 257}	50	−227	Molesworth.	„ 21	{249 / 268}	42	−154	Antoniadi.
„ 11	223	50	−225	Molesworth.	„ 22	{270 / 277}	43	−153	Antoniadi.
„ 12	{207 / 218}	53	−224	Molesworth.	„ 25	245	45	−150	Phillips.
„ 13	204	57	−223	Molesworth.	„ 26	262	37	−149	A. A. Williams.
„ 17	163	56	−219	Molesworth.	„ 27	253	27	−148	Corder.
„ 18	{147 / 159}	56	−218	Molesworth.	„ 31	180	47	−144	Phillips.
„ 19	{140 / 152}	59	−217	Molesworth.	1899. Jan. 4	153	43	−140	Phillips.
„ 22	{123 / 131}	60	−214	Antoniadi.	„ 4	167	35	−140	A. A. Williams.
„ 27	{70 / 82}	54	−209	Molesworth.	„ 4	171	42	−140	Hall.
Nov. 3	{356 / 8}	53	−202	Molesworth.	„ 8	{101 / 116}	42	−136	Antoniadi.
„ 4	359	75	−201	Phillips.	„ 8	118	43	−136	Phillips.
„ 6	{315 / 336}	51	−199	Molesworth.	„ 9	{85 / 92}	56	−135	Antoniadi.
„ 9	{276 / 306}	50	−196	Molesworth.	„ 9	87	56	−135	Crowley.
„ 11	{271 / 295}	55	−194	Molesworth.	„ 13	{48 / 63}	30	−131	Corder.
„ 11	{297 / 306}	55	−194	Antoniadi.	„ 13	59	50	−131	Phillips.
„ 13	{258 / 267}	54	−192	Molesworth.	„ 14	32	30	−130	Corder.
„ 17	{211 / 237}	56	−188	Molesworth.	„ 14	59	50	−130	Hall.

Date.	ω	α	d	Observer.
1899.				
Jan. 14	73	53	−130	Phillips.
„ 16	36	25	−128	Brown.
„ 19	{331 / 0}	38	−125	Corder.
„ 22	319	32	−122	Corder.
„ 23	330	25	−121	Brown.
„ 23	332	35	−121	A. A. Williams.
„ 24	321	25	−120	Killip.
„ 24	357	54	−120	Phillips.
„ 25	285	27	−119	Brown.
„ 25	{309 / 328}	50	−119	Antoniadi.
„ 25	292	38	−119	Mee.
„ 26	273	30	−118	Corder.
„ 26	280	27	−118	Brown.
„ 26	288	48	−118	Attkins.
„ 26	306	37	−118	Killip.
„ 26	314	34	−118	A. A. Williams.
„ 27	268	32	−117	Mee.
„ 27	330	40	−117	Kempthorne
„ 28	{228 / 236}	43	−116	Antoniadi.
„ 30	301	50	−114	Phillips.
Feb. 1	{210 / 272}	55	−112	Phillips.
„ 1	224	35	−112	Corder.
„ 1	225	28	−112	Brown.
„ 1	264	24	−112	Townshend.
„ 2	205	33	−111	Kempthorne
„ 2	235	34	−111	Mee.
„ 2	{242 / 257}	46	−111	Antoniadi.
„ 2	251	36	−111	Hall.
„ 2	259	37	−111	A. A. Williams.
„ 3	206	36	−110	Hall.
„ 3	234	43	−110	Attkins.
„ 3	255	38	−110	Kempthorne.
„ 4	{214 / 225}	46	−109	Antoniadi.
„ 7	196	35	−106	Corder.
„ 10	{153 / 201}	41	−103	Antoniadi.
„ 10	{158 / 203}	46	−103	Crowley.
„ 12	156	36	−101	Hall.
„ 14	91	52	− 99	Phillips.
„ 16	72	28	− 97	Corder.
„ 17	{79 / 109}	42	− 96	Antoniadi.
„ 17	86	46	− 96	Crowley.

Date.	ω	α	d	Observer.
1899.				
Feb. 17	{106 / 130}	30	− 96	Attkins.
„ 20	{28 / 38}	48	− 93	Antoniadi.
„ 21	35	38	− 92	Kempthorne.
„ 22	58	35	− 91	Killip.
„ 23	57	48	− 90	Stanley Williams.
„ 23	60	37	− 90	Kempthorne.
„ 23	71	35	− 90	Attkins.
„ 24	{42 / 69}	42	− 89	Antoniadi.
„ 24	42	27	− 89	Attkins.
„ 25	{24 / 39}	40	− 88	Antoniadi.
„ 26	29	44	− 87	Phillips.
„ 26	44	37	− 87	A. A. Williams.
„ 27	{320 / 16}	40	− 86	Antoniadi.
„ 27	345	25	− 86	Attkins.
Mar. 1	32	38	− 84	Phillips.
„ 2	309	30	− 83	Attkins.
„ 5	325	26	− 80	A. A. Williams.
„ 10	290	48	− 75	Phillips.
„ 13	266	26	− 72	Killip.
„ 14	189	35	− 71	Antoniadi.
„ 14	{207 / 255}	26	− 71	Attkins.
„ 14	249	40	− 71	Phillips.
„ 15	178	30	− 70	Killip.
Mar. 16	178	36	− 69	Antoniadi.
„ 27	124	30	− 60	Attkins.
Apr. 3	70	32	− 53	Phillips.
„ 9	337	32	− 47	Phillips.
„ 19	{254 / 261}	30	− 37	Antoniadi.
„ 21	245	26	− 35	Phillips.
May 27	257	26	+ 3	Antoniadi.
„ 30	{217 / 228}	25	+ 6	Antoniadi.
June 1	194	27	+ 8	Antoniadi.
	189	36?	+ 9	Antoniadi.
„	72	22	+ 10	Molesworth.
„ 7	{30 / 40}	29	+ 14	Molesworth.
„ 8	23	28	+ 15	Molesworth.
„ 10	4	25	+ 17	Molesworth.
„ 11	356	25	+ 18	Molesworth.
„ 12	345	23	+ 19	Molesworth.
„ 13	332	23	+ 20	Molesworth.

Date.	ω	α	d	Observer.	Date.	ω	α	d	Observer.
1899. June 16	300	21	+ 23	Molesworth.	1899. July 9	78	25	+ 46	Molesworth.
„ 20	265	24	+ 27	Molesworth.	„ 10	70	21	+ 47	Molesworth.
„ 21	256	24	+ 28	Molesworth.	„ 15	25	20	+ 52	Molesworth.
„ 22	247	23	+ 29	Molesworth.	„ 16	11	20	+ 53	Molesworth.
„ 24	225	26	+ 31	Molesworth.	„ 17	1	20	+ 54	Molesworth.
„ 26	206	22	+ 33	Molesworth.	„ 18	354	20	+ 55	Molesworth.
„ 27	200	20	+ 34	Molesworth.	„ 19	341	19	+ 56	Molesworth.
July 6	109	19	+ 43	Molesworth.	„ 20	336	20	+ 57	Molesworth.
„ 7	95	20	+ 44	Molesworth.	„ 21	324	20	+ 58	Molesworth.
„ 8	88	21	+ 45	Molesworth.	„ 22	314	19	+ 59	Molesworth.

These data are very instructive. It is interesting to see that the N. polar cap was still considerable two months after the summer solstice.

With reference to the early veiling of this cap, Molesworth adds the following considerations:—

"A study of the September drawings at once brings us to the "conclusion that the N. polar cap, during September . . . was "partially veiled from us by some obscuring medium; dense early "in September, thinner later, and finally clearing away at the "beginning of October (rather more than a month before the "spring equinox of the N. hemisphere). This obscuring medium, "I think we may assume to have been the clouds and mists of "the winter of the Martian N. pole, which covered the latter "during the process of formation, and remained covering it until "the melting of the edge of the polar cap had begun in the early "spring. If this assumption is correct, we have a strong analogy "between Mars and the earth in this respect.

"Referring to the 1896 'Report' we find that a fog-like ap-"pearance covered the edge of the N. polar cap from November "18th to early in December, about a month before the spring "equinox of the N. hemisphere.

"It will also be noticed that this year the *Maria* began to "darken again eight days before the first unveiling of the polar "cap, which would appear to point to an intimate connexion "between the two phenomena. If the irrigation theory is correct, "this might be due to the springing-up of vegetation fertilised "by the earliest flow of water from the incipient melting of the "polar cap."

The cap was seen "slightly indented at $\Omega = 310 - 315$," on December 19 by Phillips, and "flattened on f side," February 17, $\omega = 78°$ by Attkins. Its colour was, according to the former observer, an intense bluish white, like Vega.

Lastly, with reference to the dark band encircling the cap, Attkins and Townshend write that it was seen of "a very dark blue" at first, and that the colour faded with the season. This statement is confirmed by Hall when writing that "on February "21, while *Mare Acidalium* was dark, the 'sea' surrounding the "polar cap was considerably lighter than it was a month before."

PART III.

CONCLUSION.

Chart of Mars in 1898–1899.

The Chart at the end of the present "Report" is a combination of the results given in the drawings supplied by the Members of the Section. The process of combination was an arduous one. Notwithstanding, however, the arbitrary character of the task, the Director believes that the present Chart of Mars constitutes, by the mutual corroboration of most of its data, the most solid and trustworthy delineation of the planet made during the last apparition.

The Section tenders its warmest thanks to Mr. A. C. D. Crommelin, B.A., F.R.A.S., of the Royal Observatory, Greenwich, for his excellent "Ephemeris for Physical Observations of Mars, 1898–1899," published in Vol. LVIII. of the "Monthly Notices" of the Royal Astronomical Society, without which our work would have been assailed by formidable difficulties. The last column of the Ephemeris, the one concerning the passage of the Zero Meridian, was found in fair agreement with the appearance of the planet, and its difference was smaller than the errors of observation. Hence the justification for taking *Fastigium Aryn* as the Martian Greenwich on the Chart. Meantime, the measures of position taken by the Director on the most striking markings (*Sinus Sabæus*, *Mare Acidalium*, *Titanum Sinus*, *Trivium Charontis*, N. point of *Syrtis Major*, &c.) have shown (*a*) the accuracy of Prof. Schiaparelli's charts, and (*b*) the absence of any appreciable changes in the position of the dark areas. The backbone of the Chart is thus as accurate as could reasonably be expected.

It was thought advantageous to depart from the system followed in previous years, by drawing the Chart on a large scale, and printing it in such a manner that the reader might, by unfolding it, have at the same time text and map before him. This avoids turning pages, and enables to find the markings described at a glance.

The Chart contains the following abbreviations:—I. = *Insula*; *L.* = *Lacus*; *Prom.* = *Promontorium*. White spots are indicated by dotted circles. Markings conveying the idea of "land" are generally written in *upright* letters, those interpreted as meaning "water" in *inclined* letters. The names of important objects, not visible in 1898–1899, are given in brackets, while names belonging to Lowell's (1894) and Cerulli's (1899) maps, are indicated in inverted commas. The same is the case with names introduced by the Director. Overcrowding has been avoided by the use of *part* only of Schiaparelli's nomenclature, namely, those names which have been judged indispensable to the features presented by the last apparition.

The 1898–1899 Changes on Mars.

As shown in the exposition of the observations, these were—

(1) The incontestable intensification of the *Boreosyrtis*, invading, with a dark material, all the country to the E., until *Phlegra*;

(2) The separation between the *Syrtis* and *Nilosyrtis*, visible since 1896–1897;

(3) The development of "*Solis Pons*," resulting in a separation between the *Syrtis Major* and the *Sinus Sabæus*;

(4) The reappearance of *Nix Atlantica*;

(5) The remarkable "hour-glass" form of the "*Hour-glass Sea*."

On some Points connected with the Physical Constitution of Mars.

With a few exceptions, the following considerations lay no claims to originality:—

(1.) The question of the age of Mars is beyond our present grasp. Were the planet young, and its surface still warm, there would be no condensation caps at the poles, while, on the other hand, observation is reluctant to making of Mars a glacier.

(2.) The atmosphere is much more transparent than it is generally supposed to be, allowing, at times, markings on the limb to be seen quite as sharp and dark as when on the central meridian. Probably its density is also very small. It is not certain that clouds do float in such a medium. But superficial condensations (like hoar frost) are highly probable.

(3.) Should Dr. Johnstone Stoney's theory of the absence of aqueous vapour be correct, then the mean temperature of the planet would be low, harmonising, indeed, more readily with the demands of the law of inverse squares. If the theory be incorrect, and the polar caps be due to ordinary snow, then the mean temperature would not seem to be far from the 0° Centigrade. To ensure, however, such a result, the Martian atmosphere ought to contain some gas, fairly diathermanous to the luminous heat of the sun, but strongly athermanous to the reflected dark radiation from the surface. In that case only could the planet be habitable in the sense we are giving to that term.

(4.) Inasmuch as contrast ought necessarily to brighten regions approaching the limb (which, on Mars, entails an apparent change of colour from ochre to white), the phenomenon of the lands whitening with the obliquity of the visual (or solar) rays, must, to some extent at least, be subjective. If essentially objective, we have in it evidence of a considerable absorption of the solar rays by the Martian atmosphere, since, under an

increasing thickness of the gaseous envelope, the solar beam is too enfeebled to prevent precipitation.

(5.) The valuable results secured by the Section can now throw some light on the points raised by our late lamented past President, Mr. Green, at the December 1890 Meeting of the Association. There is no questioning the splendid accuracy of Prof. Schiaparelli's *outlines* of the *Maria*, but Mr. Green was right in stating that the Italian astronomer had a slight tendency to turn "soft and indefinite pieces of shading into clear, sharp, "lines." We know, at present, that the continental regions of Mars, and the N. hemisphere especially, are diversified by extensive, though exceedingly faint shadings, of almost all degrees of delicacy, visible to some observers, invisible to others, but on whose objective reality no reasonable doubts could be entertained.

(6.) From an analysis of past work, but chiefly from Rev. P. H. Kempthorne's valuable observations given in this "Report," we now know for certain that a considerable number of the so-called "canals" coincide with the boundaries of adjacent areas of different *albedos*. The fact is significant.* Generalising, however, on this point, by considering *all* the canals to be edges of shades, would be dangerous at present. But great credit is due to Mr. Maunder for having suggested this explanation for *some* canals almost 20 years ago.

(7.) The evidence in favour of objective change on Mars, beyond the obvious melting of the snows, is strong. A single instance, drawn from the present "Memoir" will suffice to illustrate this. In 1883–1884 the *Boreosyrtis* was a narrow dark band, surrounded by a bright area. In the comparable opposition of 1898–1899, a prodigious mass of dark material covered at least 10 times the area of the 1883–1884 band. Obviously, such discrepancies, seem far outside observational errors. And if change occur on such a gigantic scale on a given point of the planet, it is likely to affect, in a more or less attenuated form, all other parts of the Martian surface.

(8.) But little aquatic is the deportment of the *Maria*. Variability of intensity and outline are not the characteristics of water areas.

(9.) "Lakes" forming on the intersection of widening canals are not necessarily real, but might be superposition images ("Journal," Vol. XI., No. 1). Of course, this interpretation does not apply to real, permanent markings, but simply to some exceedingly small dots, invisible when the canals are narrow, but visible only when the breadth of the latter is increasing.

---

* In this connexion, the following extract from the report of the Meeting above alluded to is eloquent:—"Mr. Green added that he had himself been "deceived sometimes by the edges of large faint tones, and had drawn them "with a single line, only to find out his mistake when the form came to the "meridian, and its whole shape was made evident."—"Journal," Vol. I., p. 113.

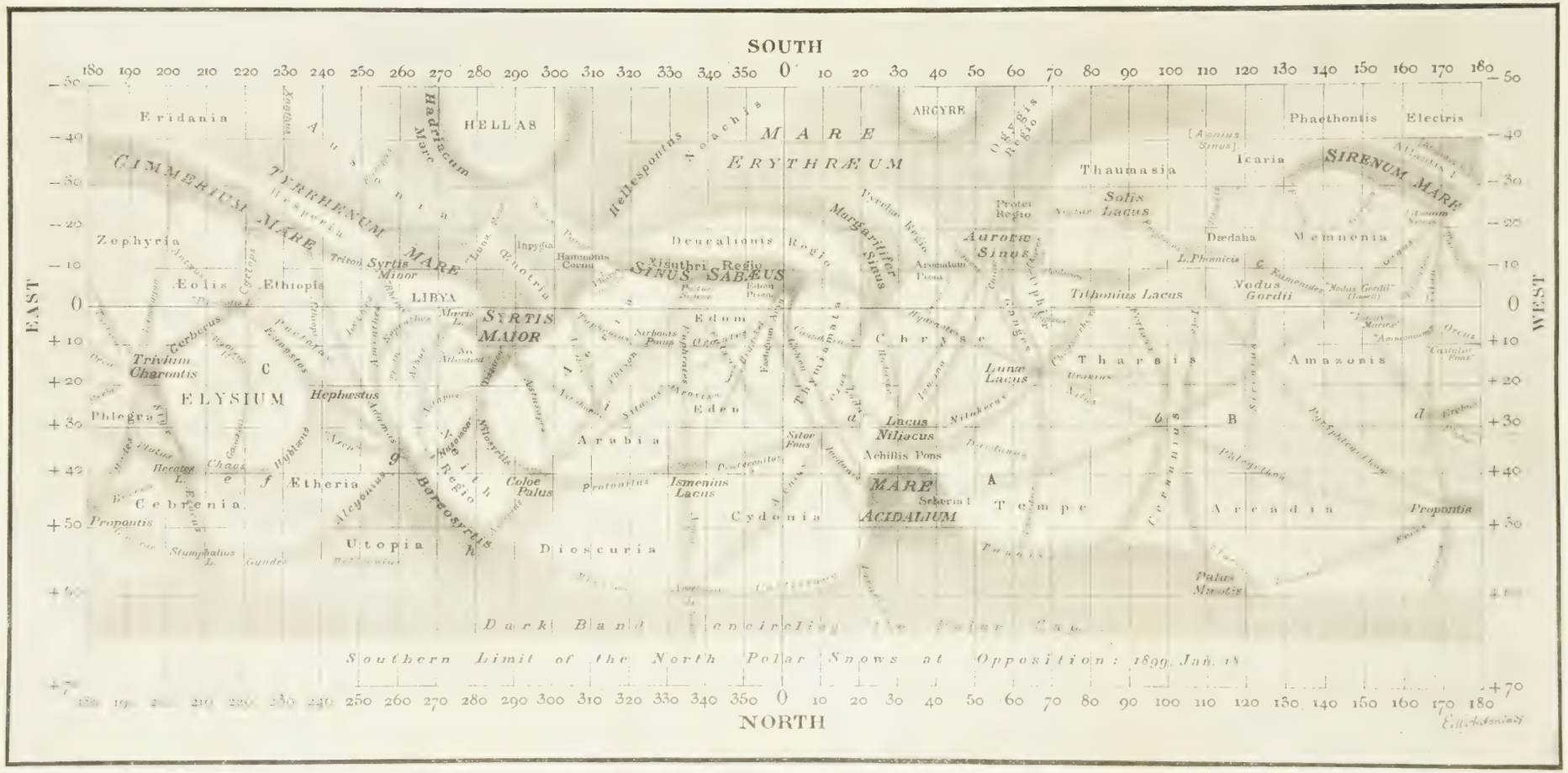


Chart of Mars, on Mercator's Projection.

Prepared from Observations of the Section in 1898–99.

Fig.1. H. Corder. $6\frac{1}{2}$ in. Spec.
1899. Jan. $19^d\ 9^h30^m$. $\omega=0°\ \phi=+11°5$

Fig.2. E. M. Antoniadi. $10\frac{1}{2}$ in. O.G.
1899. Feb. $20^d\ 6^h11^m$. $\omega=28°\ \phi=+8°5$

Fig.3. P.H. Kempthorne $12\frac{1}{2}$ in. Spec.
1899. Feb. $21^d\ 7^h15^m$. $\omega=35°\ \phi=+8°5$.

Fig.4. A. S. Williams. $6\frac{1}{2}$ in. Spec.
1899. Feb. $23^d\ 10^h\ 0^m$. $\omega=57°\ \phi=+8°6$.

Fig.5. L. A. Crowley 7 in. O.G.
1899. Feb. $17^d\ 8^h20^m$. $\omega=86°\ \phi=+8°6$

Fig.6. T. E. R. Phillips. $9\frac{1}{4}$ in. Spec.
1899. Feb. $14^d\ 6^h15^m$. $\omega=91°\ \phi=+8°7$.

Fig.1. P. B. Molesworth. $12\frac{1}{2}^{in}$ Spec.
1898. Oct. $22^d 10^h 46^m$ ω=121° ϕ=+13°9

Fig.2. P. B. Molesworth. $12\frac{1}{2}^{in}$ Spec.
1898. May. $25^d 11^h 50^m$ ω=143° ϕ=20°

Fig.3. T. E. R. Phillips. $9\frac{1}{4}^{in}$ Spec.
1899. Jan. $4^d 11^h 0^m$ ω=153° ϕ=+13°8.

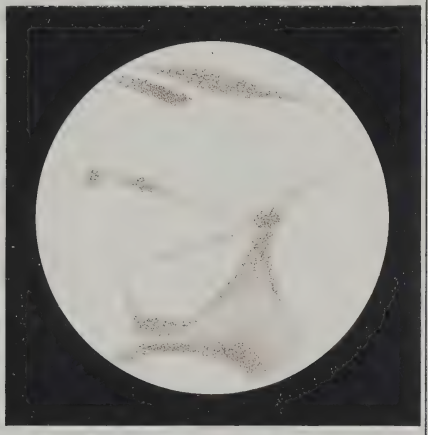


Fig. 4. T. E. R. Phillips. $9\frac{1}{4}^{in}$ Spec.
1898. Dec. $31^d 10^h 15^m$ ω=180° ϕ=+14°4

Fig.5. E. Attkins. $6\frac{1}{2}^{in}$ Spec.
1899. March $14^d 7^h 35^m$ ω=207° ϕ=+9°6.

Fig.6. G. L. Brown. $10\frac{1}{4}^{in}$ Spec.
1899. Feb. $1^d 7^h 59^m$ ω=225° ϕ=+9°7

MARS 1898–99.

Fig.1. W.J. Hall. $4\frac{7}{8}^{in}$ Spec.
1899. Feb. $2^d 10^h 25^m$. $\omega = 25°$. $\rho = +9°5$

Fig.2. A.A. Williams. 5^{in} Spec.
1899. Feb. $2^d 11^h 0^m$. $\omega = 259°$. $\rho = +9°5$.

Fig.3 H.J. Townshend. $9\frac{1}{2}^{in}$ Spec.
1899. Feb $1^d 10^h 45^m$. $\omega = 264°$. $\rho = +9°7$.

Fig.4. A. Mee. $8\frac{1}{2}^{in}$ Spec.
1899. Jan. $25^d 8^h 25^m$. $\omega = 292°$. $\rho = +10°6$

Fig.5 R. Killip. 5^{in} O.G.
1899. Jan. $24^d 10^h 30^m$. $\omega = 321°$. $\rho = +10°7$.

Fig.6. E.M. Antoniadi. $10\frac{1}{2}^{in}$ O.G.
1899. Feb. $27^d 6^h 51^m$. $\omega = 334°$. $\rho = +8°6$.

Tailby & Price. Lith.

SECTION FOR THE OBSERVATION

OF

SATURN

DIRECTOR—G. M. SEABROKE, F.R.A.S.

REPORT OF THE SECTION.

This Section has for its Members Mr. Smart, Mr. Garrard (having a 5¼-in. refractor), Mr. Griffiths, Mr. Bullock (a 3-in. refractor), Mr. Bolton, the Rev. T. H. Foulkes, Mr. H. J. Townshend (a 10-in. reflector) Mr. C. T. Whitmell, Mr. E. Essam, and Mr. A. Mee.

Owing to the low altitude of the planet for some time past the observations of the Section are not numerous, and it is surprising that the drawings I have received are as good as they are. Again, the distance of Saturn—some 840 millions of miles—was large at the last opposition.

Mr. Townshend remarks having seen the N. pole of the planet of a deep orange colour, and Mr. C. T. Whitmell has contributed a paper showing, on theoretical grounds, how certain parts of the planet may be coloured owing to the dispersion of light in traversing our atmosphere.

Mr. Townshend says the belts were not observed last year as triple, but only double, and Mr. Stanley Williams remarks on his seeing two faint and diffuse belts just N. of the bright equatorial zone.

Mr. Garrard, who sends a drawing, also concurs in seeing two belts only, which were on most nights seen as a broad shading.

Mr. Bolton has made some remarkably fine drawings of the planet, one of which is here reproduced (Fig. 1).

FIG. 1.

The point worthy of chief note is that the outline of the shadow of the globe where it crosses the rings is not a continuous line, but is broken into a step such as would be formed were the surfaces of the rings not at the same level. This feature is shown as existing in the several drawings appearing on Fig. 2, on various dates.

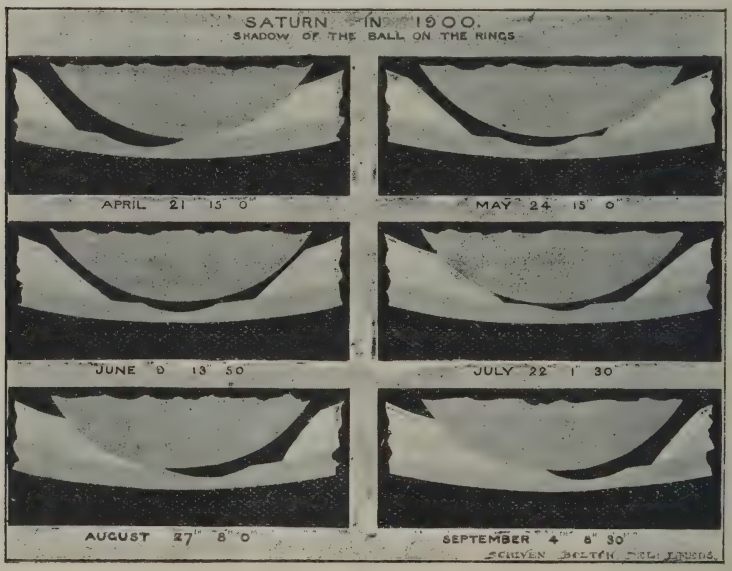

SATURN IN 1900.
SHADOW OF THE BALL ON THE RINGS
APRIL 21 15 0
MAY 24 15 0
JUNE 9 13 50
JULY 22 1 30
AUGUST 27 8 0
SEPTEMBER 4 8 30
SCRIVEN BOLTON DEL. LEEDS.

FIG. 2.

It might also be caused by the outer ring being thicker than the next; on either of these hypotheses suggested by Mr. Bolton the observations might be accounted for. The diagrammatic plan seen on Fig. 3. explains more fully the appearances on either hypothesis.

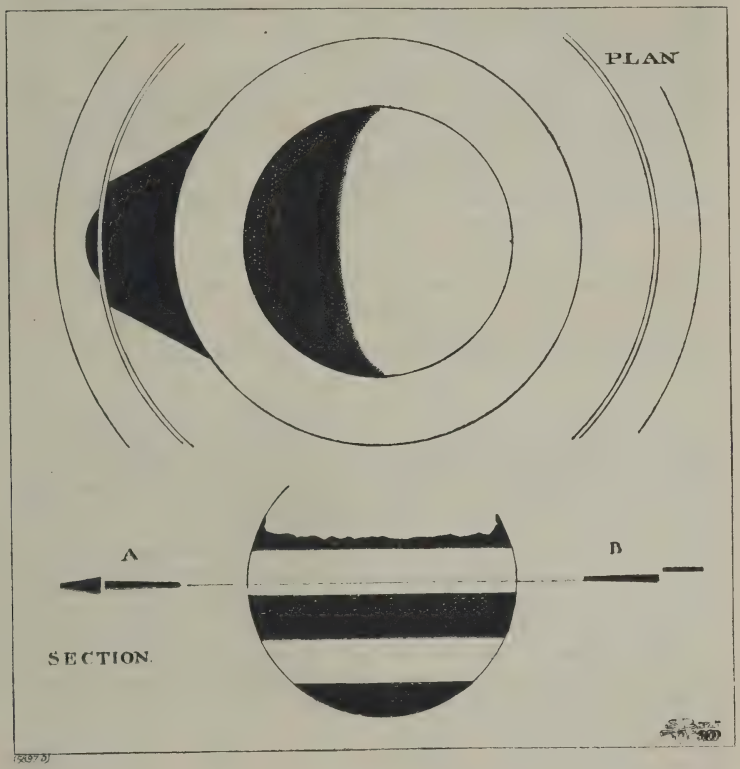


FIG. 3.

A shows the explanation on the assumption of a thickened ring, and B with the outer ring raised above the plane of the middle ring. Something of the same sort has been observed before, and has been thought to be due to irradiation, but it is no new thing to allege that the rings do not lie on the same plane, though the evidence is anything but conclusive. From the fact that the rings disappear, or nearly so, when seen edgewise, it is scarcely probable that one can be so much thicker than the other as to cause the appearance in question, and one must suspect the effect to be an optical one.

In a paper to the Royal Astronomical Society, by M. C. Flammarion, January 1901 (**M.N.**, Vol. 61., No. 3), the writer remarks that the shadow of the planet had an irregular outline owing to the varying luminosity of the ring. Irradiation caused it to appear to turn round in a sharp curve into the Cassini division. His sketch shows a very similar phenomenon to that of Mr. Bolton, and both are evidently due to the same cause.

The curves of the outline of the shadow of the ring on the planet have been studied by Mr. C. T. Whitmell, and the forms of such curves at various inclinations of the ring to the sun and earth have been set forth in his paper, printed in the "Journal," Vol. X., pp. 67–71. A problem in sphero-conics is involved, which Mr. Whitmell solves in the paper in question, and shows that in certain cases the outline is a curve of double curvature, which, at first sight, is not to be expected.

On pages 198–202 of Vol. XI. of the "Journal," will be found Mr. Whitmell's discussion of the times taken for the immersion and emersion respectively during an occultation of Saturn, with an explanation of the reasons for the differences, and on pages 34 and 35 will be found Mr. Newbegin's and Mr. Astbury's observations of the occultation of 3rd September 1900, which gave rise to Mr. Whitmell's paper.

REPORT OF MR. J. GARRARD USING A 5¼-IN. ACHROMATIC REFRACTOR,

Equatorially mounted at Louth, Lincolnshire, Long. 0° 0′ 0″, *Lat.* 53° 22′ *N.*

Saturn in 1900 has been a disappointing object to observe. Its low elevation above the horizon, combined with a run of poor observing weather, has rendered most observations nearly useless.

One comprehensive drawing has been made from sketches and notes on the best nights. It shows all that could be seen at any time distinctly.

Cassini's division was generally seen on clear nights in the extremities of the ellipse. On a few of the best nights it was clearly traced *all round.*

The shadows of the ball on the ring and of the rings on the ball were generally well seen, and, on best occasions, of great sharpness on their edges, appearing clean cut.

The equatorial double belt was on most nights seen as a single broad shading, rather faint, but on two or three occasions was distinctly to be seen double.

The illumination of the inner bright ring was the most brilliant of the whole system on all occasions. This ring seemed to fade off in brilliancy towards its inner edge. The outer ring beyond Cassini's division was always darker, and generally the *darkest* portion of the entire system, being almost as dark as the equatorial belts. The ball of the planet was intermediate between the inner and outer bright rings in brilliancy. The lower (N.) portion was observed as darker than the S. (January 24th and other dates).

The Crape Ring was not seen with certainty.

The colour of Saturn and his system as a whole seemed a pale nondescript yellow, or dirty white. Especially was this the case on the occasions of the occultations, when the light of the moon was available for comparison. No other colour was noted on any part of the ball or rings. The equatorial belts appeared to be merely faintly shaded by neutral grey.

The Satellites were not critically observed, nor was any attempt made to identify them, and although Saturn passed at one time before a thick cluster of telescopic stars, no attempts were made to measure or time near approaches or contacts, either of planet or satellites, with any of the stars.

Observations that call for particular note were :—

June 13th 1900.—Occultation. The disappearance was missed on account of clouds. Re-appearance was noted to commence at 9.53 p.m. Planet came quite sharply from the dark limb, showing not the slightest distortion or dimness to the very edge of the moon. Its colour, by contrast with the moon, seemed much fainter and paler, and of a dirty parchment colour.

July 1st.—The equatorial belt was seen double. Its components were very sharply edged, and narrow.

July 24th.—Definition nearly perfect; power 160. Equatorial band shown clearly double and quite sharp. Cassini's division seen all round. Outer edge of outer ring seemed much shaded. N. part of ball seemed darker than S.

July 28th.—Cassini's division seen easily all round. Equatorial band clearly double.

August 14th.—Heavy dew. Best view of season. Cassini's division has a jet black line all round, plainer than it was ever seen from here before. Equatorial belt clearly defined and double, but very pale and delicate. N. edge of ball bordered by its shadow. Edge of shadow seemed just to leave none of the ring visible beneath it. Edge of ring and edge of shadow appeared in contact.

September 3rd.—The other occultation could not be properly observed for mist.

No other observations were worth noticing, notwithstanding the fact that the planet was observed on nearly every available night.

REPORT OF MR. H. J. TOWNSHEND, OF LEEDS, USING A 10-IN. REFLECTOR.

On the night of opposition, 23rd June 1900, Saturn was not visible, being completely obscured by clouds. I got my first good view of him on July 10. I saw Cassini's division at the ansæ only, and the C ring very narrow and not distinct, but I saw the shadow of the ball upon the ring system at the N.E. evenly again all around the planet's N. pole.

On July 15, at $10^h\ 45^m$, I obtained my best view of the planet. Cassini's division was seen all round, except where interrupted by the shadow of the ball upon the ring system, and this shadow was again perpendicular to the N. pole, and Cassini's division was tangential to the N. pole—I should say exactly so, this opposition. At the opposition of 1899 Cassini's division was clearly *below* the level of the N. pole. The shadow of the rings upon the southern region of the ball was distinct this year, and the C ring was

fairly well seen, moderately broad and dark, against the B ring. I could not make the belts triple this year, but I discerned an oblong dark marking on the N. preceding side, well within the belt system. In previous years I have *always* seen the belt system triple, as if they were N. equatorial belt, S. equatorial belt, and equatorial belt, similar to Jupiter's system of equatorial belts, with this difference, that, in the case of Jupiter, the N. and S. equatorial belts are both broad, and the equatorial belt fine and narrow; whereas in the case of Saturn they seem to me all of uniform width. I think I failed to see the triple set of belts only because of the great distance of the planet, with low altitudes, obscuring the disc in the smoky atmosphere of Leeds.

With respect to my idea of the Saturnian equatorial belts being similar to Jupiter's, but all of uniform width, instead of, as in Jupiter's case—two wide, *i.e.*, north and south, and one very fine, line-like, *i.e.*, the equatorial—I always saw them triple, and placed fairly in the planet's centre, and at uniform distances apart. I did not see the three belts this last opposition, I believe, for reasons stated above, but I observed Saturn only seven times altogether. The planet's great distance and low altitude made him a very difficult object for me.

In 1899 I saw the N. pole of the planet of a deep orange colour. This may have been due to atmospheric dispersion of light.* The ring system being below the N. pole of planet may overpower that region, and so give it that colour. I believe such a phenomenon could not occur to either sun, moon, or any other planet without the ring system, and then only with Saturn when the ring system is below the planet's N. pole. Without the ring system the N. pole of sun, moon, or planet is, I believe, always blue, by dispersion of light, when at a low altitude. The last time I saw Saturn's equatorial belts triple was on 15th and 17th June 1899.

REPORT OF MR. A. MEE, AT CARDIFF, USING AN 8½-IN. REFLECTOR.

Occultation of Saturn, September 3, 1900, observed under very fair conditions considering the low altitude of Saturn. Definition not good enough to make any note on behaviour of image at moon's limb. The time of bisection was, as nearly as possible, at ingress, $8^h\ 7^m$. The effect of the occultation by the moon's invisible dark limb was striking. Comparison of colours:—Moon bright golden, Saturn zinc; power 60.

COLOUR ON THE PLANET.

MR. C. T. WHITMELL offers the following explanation of the colour of certain areas on the planet.

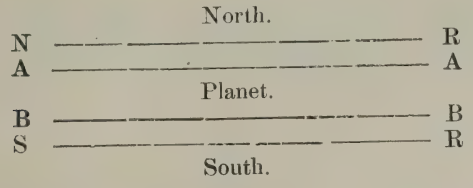
Assume, for simplicity, that a planet is on the meridian, so that its N. limb is at the top and its S. limb at the bottom.

When a planet's altitude is low, the N. limb may appear blue, the S. limb orange, owing to atmospheric dispersion.

* This explanation was furnished by Mr. Whitmell.

But, in the case of Saturn, the bright rings complicate the matter.

In the figure (diagrammatic) N R and S R are the N. and S. external limits of the ring system. A A and B B are the N. and S. apparent common meeting lines (as it were) of ring and planet.



Dispersion, acting on the ring-light, will colour N R blue and A A orange; also B B blue and S R orange. Dispersion, acting on the planet light, will not affect N R or S R, but will make A A blue and B B orange.

Now A A will be orange from ring dispersion, but blue from planet dispersion; whilst B B will be blue from ring dispersion, but orange from planet dispersion. Were ring and planet equally bright, A A and B B would not exhibit colour, the dispersions compensating each other. But as the ring is brighter than the planet, it is possible that A A will have an orange and B B a bluish tinge, that is to say, colours just the opposite of what would be the case were the ring absent, so that Saturn could be seen isolated like Jupiter. I think that in estimating the colour of the N. and S. region of Saturn at low altitudes, this possible effect of the ring should not be overlooked.

On the moon I have seen peaks, which were brighter than the illuminated lunar surface surrounding their bases, show distinct dispersion colours. I should be glad if observers with good telescopes will observe Saturn for dispersion colours, and let me hear the results.

About the time of the northern summer solstice of Saturn, I should expect the dispersion of ring-light to produce its principal effect on the southern region of the planet, because the bright B ring then passes near a southern zone darkened by the C ring. With the planet at a moderate altitude this zone may be expected to show a bluish tint.

At the same season, the A ring is adjacent to the planet's N. pole. This ring is dimmer than the B ring, but must still be brighter than the planet's polar region, if the orange colour of the latter resulted from dispersion; for, if the ring were absent, dispersion would colour the region blue. The bright B ring may affect the limb of the planet just S. of its N. polar region.

Memoirs

OF THE

British Astronomical Association.

EDITED BY

F. W. LEVANDER, F.R.A.S.

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SECTION FOR THE OBSERVATION

OF

METEORS.

DIRECTOR—WALTER E. BESLEY.

REPORT OF THE SECTION, 1900.

Introductory.

During the past year the Meteoric Section has sustained the great loss of the services, as Director, of Mr. Denning, who resigned the post, on account of ill-health, at the end of June, after filling it for about 15 months only. The present Director, after acting as deputy during the summer months, was elected to succeed Mr. Denning at the Meeting of the Council on October 10.

The number of Members of the Section remains about the same as in 1899, and a large collection of observations has been under discussion. Messrs. Astbury, Bridger, Brook, and King have periodically contributed valuable meteor-lists, and these have been supplemented by many notes from other observers, both of the Section and of the Association at large. Mr. Scriven Bolton, of Leeds, who joined the Section about the beginning of November, has supplied some interesting meteoric records of the three years 1898–1900.

Prof. A. S. Herschel, of Slough, has again very kindly furnished copies of his observations from time to time, and these have been of very great value in amplifying the records of the Section and for comparison with them.

In spite of his ill-health and, it is to be feared, often at the cost of great personal discomfort, Mr. Denning has continued his watches for meteors, and has also allowed the results to be referred to in this Report. How complete these are will be gathered from the following pages.

Mr. C. L. Brook, of Meltham, Huddersfield, has prepared a skeleton map, showing lines of right ascension and declination, for use in charting meteors. He has kindly offered to present some copies of this, when published, to the Section, and they will undoubtedly be of assistance to some of the Members.

In response to a request by Mr. Denning, Mr. David Ross, Honorary Secretary to the Victoria Branch of the Association, brought the subject of meteoric observation before its Members.

It is greatly to be hoped that progress may be made before long in this direction in the southern hemisphere.

The Rev. E. G. Roberts, of Masulipatam, has unfortunately been in ill-health and unable to continue his excellent meteoric work in India. He points out that much might be done there by a European with some talent for organisation.

The Report, which has been drawn up on the usual lines, may be regarded as consisting of two parts, the first of which deals for the most part with observations of meteoric showers ("Record of Meteoric Observations, 1900," and "Radiant Points of Meteoric Showers, 1900,") and the second of which has to do with individual fireballs and meteors ("The Fireballs of 1900," "Real "Paths of Fireballs and Shooting Stars observed at two or "more Stations in 1900," and "Bright Meteors observed during 1900").

Two Interim Reports have been presented during the year:— "The Perseids, 1900" (*see* the "Journal," Vol. X., page 420), and "The Leonids, 1900" (Vol. XI., page 56).

The Tables of "Real Paths," mentioned above, have been compiled by Mr. Denning and Prof. Herschel; that by Prof. Herschel (including fresh calculations for two meteors of 1899) supplementing Mr. Denning's by new data, and also containing additional determinations, with a series of valuable notes, in some cases where the placing of a different construction on discordant or indefinite observations has suggested itself. In these instances the tables show the probable differences to be expected between independent computations of real paths. To these and all other observers who have assisted in the work of the Section the Director begs to express his thanks.

Record of Meteoric Observations, 1900.

QUADRANTIDS.

The opening meteoric shower of the year furnished a fine display. On January 2 Mr. T. H. Astbury, at Wallingford, and Mr. J. H. Bridger, at Farnborough, watched from $5^h\ 20^m$ to 7^h and from $5^h\ 35^m$ to $7^h\ 3^m$ respectively. The former recorded six meteors, of which four were Quadrantids, and the latter three meteors including two Quadrantids, besides glimpsing three other meteors, of which one was, perhaps, a Quadrantid. Mr. Astbury noted three Quadrantids and four other meteors in a further watch from 10^h to 11^h, in the first 35^m of which, however, not a single shooting-star was seen; three of these seven were of the first magnitude.

Prof. Herschel's observations, made at Slough, between 11^h and $16^h\ 30^m$, add greatly to the history of the Quadrantid shower. During this long-continued watch 130 shooting stars were seen, 80 of these being mapped. The meteors were principally of the first and second magnitudes, but one was as bright as Venus and another three or four times more brilliant than that planet. Twenty-nine Quadrantids gave a radiant point at $229° + 52°$.

At Clapham watch was kept from $11^h\ 30^m$ to 13^h, with the result that 25 meteors (13 Quadrantids) were registered, and a few

more imperfectly seen. Four Quadrantids were as bright as first magnitude stars. The meteors of the shower in question appeared to be most numerous at the following times :—

$11^h\ 42^m$ to $11^h\ 53^m$	- -	5 Quadrantids.
$12^h\ 54^m$ to $13^h\ 0^m$	- -	4 „

A first magnitude meteor, probably a Quadrantid, was observed at $11^h\ 47\frac{1}{4}^m$ by the Rev. S. J. Johnson, at Bridport.

As showing the progress of the shower at a later hour, it may be mentioned that a report from Mr. Bridger states that he has been informed that several shooting stars were seen at Chalfont, in Buckinghamshire, between 18^h and $18^h\ 30^m$, which "had tails and burst like rockets."

Sixteen meteors were recorded during the period January 20–27 by Mr. A. King, at Leicester, nine by Mr. Astbury, on January 24 and 25, and four (three others glimpsed), by Mr. Bridger on January 25. Not many of these seem to have proceeded from common radiants, those best indicated being at $85° + 42°$ and $132° + 34°$.

MARCH METEORS.

Mr. Bridger saw 33 shooting stars in March, the positions of 23 of these being definitely determined. The aggregate length of watches when discounted was $10^h\ 22^m$ (principally during the period March 20–31). Mr. King observed eight meteors between March 20 and 31, one being greater than, and two equal to, the first magnitude, and Mr. Astbury six between the same dates.

Prof. Herschel contributed a list of 28 meteors observed between March 26 and April 2 (the chief watches being between 10^h and 12^h on March 28, 10 meteors; $10^h\ 45^m$ and $11^h\ 45^m$ on March 30, 5 meteors; $8^h\ 15^m$ and $11^h\ 30^m$ on March 30, 4 meteors).

LYRIDS.

Mr. Bridger observed the Lyrid shower under very favourable weather conditions on April 19–21. The times of watches and numbers of meteors seen were as follows :—April 19, $9^h\ 43^m$ to $11^h\ 38^m$, 5 meteors; April 20, $8^h\ 58^m$ to $11^h\ 43^m$, 18 meteors; April 21, $8^h\ 28^m$ to $9^h\ 27^m$ and $9^h\ 48^m$ to $11^h\ 53^m$, 24 meteors. The numbers of meteors registered were 4, 9, and 15 respectively. Six Lyrids were noted on April 21 and one on each of the two other dates.

Mr. Astbury recorded four meteors in a watch from $9^h\ 44^m$ to $10^h\ 10^m$ on April 20, and six between almost identical times on the following night. Two of these latter were Lyrids. Two first magnitude meteors—the first white, the second red—were observed by the Rev. S. J. Johnson at $11^h\ 13^m$ and $11^h\ 23\frac{3}{4}^m$ respectively. Four meteors, of which one or, perhaps, two, were Lyrids, were seen between 10^h and $10^h\ 18^m$ on April 20 by Mr. H. Corder, at Bridgwater. Mr. King observed from 10^h to $12^h\ 30^m$ on April 20, and from $10^h\ 30^m$ to 13^h on April 21, registering four Lyrids on each occasion among totals of 15 and 12 meteors respectively. Mr. C. L. Brook, on board a ship anchored off the island of Tanera More, in Loch Broom, near Ullapool, on the west coast of Scotland, observed two Lyrids and 10 other meteors between

$10^h\ 15^m$ and 12^h on April 20. On the same date Mr. F. Elgee, at Middlesbrough, noted only two meteors, one, perhaps, being a Lyrid, from $10^h\ 30^m$ to 13^h.

Prof. Herschel has drawn up the following table of radiants deduced from the tracks of the meteors observed by Members of the Section, combined with those of 13 meteors recorded by Mr. J. C. W. Herschel, at Cambridge, and 16 by Mr. A. R. Hinks at the same place, on April 18–20, 127 shooting-stars in all having been under consideration.

Radiant or nearly Collocated Group of Radiant Points, including one Principal or Chief Radiant Point.	Number of Mapped Meteors.
Lyra	23
f, *g* Lupi ($218°-31°\pm$)	13
Corvids ($175°$ to $190°-25°$ to $30°$), three meteors (one triply observed, Slough, Farnborough, and Wallingford).	6
α Scorpiids ($250°-20°\pm$) three meteors	
δ and π Herculids ($255°+25°$, and $+37°\pm$)	12
C and *F* Cerberids ($270°+22°$, and $285°+23°\pm$)	13
η, ι Draconids ($233°+63°\pm$)	11
κ (and α) Cephei ($310°+77°$, $316°+61°\pm$)	9
o, *b*, μ, and 26 Draconis	8
Canes Venatici and ϵ, η Ursæ Majoris	9
Valpeculids, Pegasids, or β and ζ Cygnids	9
Total	113

The Lyrid centre was at $275°+35°$ with a radius of $3°$ or $4°$. [In the general table of radiant-points the positions given are those deduced from the meteor-tracks registered by various observers separately, such positions being also for the most part represented above.]

During the period April 15–21, 77 meteors were observed by Prof. Herschel, chiefly on the nights of April 19 ($9^h\ 15^m$ to $10^h\ 45^m$ and 11^h to $14^h\ 15^m$, 11 meteors); 20 ($9^h\ 15^m$ to $11^h\ 15^m$ and $11^h\ 45^m$ to $14^h\ 15^m$, 26 meteors); and 21 ($9^h\ 40^m$ to $11^h\ 20^m$ and $11^h\ 40^m$ to $14^h\ 15^m$, 34 meteors). About 15 Lyrids were seen, the principal radiant being at $277° + 30°$.

May Aquarids.

Prof. Herschel recorded 21 shooting stars in the first week of May, two of these (both on May 3) being Aquarids. One of these latter was seen at Farnborough by Mr. Bridger, who kept watch for about 5^h in all on three mornings in the early part of the month. No other out of 10 meteors was an Aquarid.

On May 22, $11^h\ 3^m$ to $11^h\ 48\frac{1}{2}^m$; 24, $11^h\ 7^m$ to $11^h\ 58^m$; 28, $11^h\ 43^m$ to $11^h\ 58^m$, five, seven, and four meteors respectively were observed by Mr. King. Two others were noted on May 29. Several bright objects were included in these numbers, one being greater than, and two equal to, the first magnitude, and three equal to magnitude $1\frac{1}{2}$.

JULY PERSEIDS.

Owing to the fact that a full moon was due about the maximum date of the Perseid shower in August, a special effort was made to obtain observations of the July portion of the display, and with a good measure of success. Before proceeding to more detailed remarks, it will be convenient to summarise, as far as possible, the hours of watch, &c., for the latter half of July.

Date.	Watch. From	Watch. To	Total Number of Meteors seen.	Observer.
1900.	h m	h m		
July 15 -	10 12	11 30	3	W. F. D.
„ 17 -	11 35	12 0	3	A. S. H.
„ 18 -	10 0	10 30	3	W. E. B.
„ „ -	10 16	11 40	7	W. F. D.
„ „ -	11 10	12 0	2	A. S. H.
„ 19 -	10 0	11 25	7	W. E. B.
„ „ -	11 38	11 59	3	W. F. D.
„ „ -	11 45	12 5	2	A. S. H.
„ 20 -	10 0	12 30	12	W. E. B.
„ „ -	11 15	12 0	6	A. S. H.
„ 21 -	11 0	11 30	3	A. K.
„ 22 -	10 57	11 15	3	W. F. D.
„ 23 -	9 45	13 30	30	W. E. B.
„ „ -	9 49	11 7	6	J. H. B.
„ „ -	10 30	13 0	13	W. F. D.
„ „ -	11 15	12 0	2	A. K.
„ „ -	11 55	12 15	6	A. S. H.
„ 24 -	9 52	11 5	11	J. H. B.
„ „ -	10 0	14 20	51	W. E. B.
„ „ -	10 40	11 40	11	A. K.
„ „ -	10 42	14 27	44	W. F. D.
„ „ -	11 50	12 10	2	A. S. H.
„ 25 -	10 15	11 15	6	W. E. B.
„ „ -	10 45	12 47	19	W. F. D.
„ „ -	11 0	11 35	5	A. S. H.
„ 26 -	9 45	11 45	10	W. E. B.
„ „ -	10 2	10 38	3	J. H. B.
„ „ -	10 30	11 5	9	W. F. D.
„ „ -	10 50	11 40	12	C. L. B.
„ „ -	11 49	12 2	1	T. W. B.
„ 27 -	11 40	12 0	1	A. S. H.
„ 28 -	9 25	11 14	16	J. H. B.
„ „ -	10 30	12 30	8	W. E. B.
„ „ -	10 45	12 0	5	C. L. B.
„ „ -	10 45	12 0	6	A. K.
„ „ -	11 40	12 40	12	W. F. D.
„ „ -	11 45	12 35	8	A. S. H.
„ 29 -	11 25	11 50	2	A. K.
„ 30 -	9 30	11 41	21	J. H. B.
„ „ -	10 14	10 26	3	T. H. A.
„ „ -	10 15	12 0	12	A. K.
„ „ -	10 30	14 30	57	W. F. D.
„ „ -	11 35	12 5	7	A. S. H.
„ 31 -	9 22	11 34	9	J. H. B.
„ „ -	10 20	11 0	2	W. E. B.
„ „ -	10 45	11 15	5	A. S. H.

One of the meteors recorded by Mr. Denning on July 15, of the 4th magnitude, at $11^h\ 10^m$, was possibly a Perseid, though it may have rather belonged to a radiant at $25° + 44°$. On the 18th, however, a meteor of the 5th magnitude, noted by him at $10^h\ 38^m$, was an undoubted Perseid. A brilliant Perseid at $11^h\ 49^m$, on July 19, was observed by Prof. Herschel and Mr. Denning, while another was recorded at $12^h\ 12^m$, on July 23, by the same observers, and also at Clapham. The first Perseids seen at Clapham were two on the 19th and 20th respectively.

Mr. Denning observed 177 shooting-stars between July 15 and 30. Twenty Perseids were included in this number, 10 of these being noted on July 30. At $11^h\ 3^m$, on the 24th, there was an extraordinary dull nebulous meteor of the 4th magnitude travelling from $324° + 25°$ to $140° + 69°$, in about $7\frac{1}{2}$ seconds. Its radiant was $321° - 33°$. The Aquarid radiant furnished more meteors than the Perseid, there being a good display of the former in the last week of the month, with 15 on July 30. On July 26, at $12^h\ 12\frac{1}{2}^m$, a greenish 1st magnitude Aquarid, with a short course, was noted by the Rev. S. J. Johnson, at Bridport.

Prof. Herschel recorded in July 47 meteors, of which about eight were from radiants in Perseus. Five or six Aquarids were noted, chiefly on July 30 and 31, though one was seen as early as July 17. Besides the positions given in the table of radiant-points, Prof. Herschel forwarded the following list of weak centres observed at this period:—

240° + 63°	310° − 10°
242° + 47°	312° + 59°
280° − 14°	314° + 49°
297° − 11°	343° + 10°

The third and fourth of these are particularly interesting as being the radiants of the fireballs of July 24, $10^h\ 49^m$, and July 15, $10^h\ 13^m$, respectively.

From July 18 to 31, 129 meteors were observed at Clapham, 15 being as bright as, or brighter than, 1st magnitude stars. About 18 of the total number were Perseids, two-thirds of these appearing on July 23 and 24.

The total number of meteors seen in this month by Mr. King, at Ilfracombe, was 36, of which 29 were recorded (from July 21 to 30th). The only Perseid noted was seen on July 21. On July 24, three fine green meteors were observed. They moved with moderate velocity, and their radiant was at about $306° - 17°$.

Mr. Bridger's watches during the period July 23 to 31 resulted in the observation of 32 meteors, while 34 others were glimpsed. The probable numbers of Perseids were 2, 1, 4, and 2 on July 24, 28, 30, and 31 respectively. One or two Aquarids were seen, but the principal minor shower was the Cassiopeid with a radiant area within one degree.

Mr. W. H. Milligan watched at Belfast from $9^h\ 30^m$ to $10^h\ 30^m$ on each of the nights July 24, 25, 26, and 30, but reported that Perseid radiation was *nil*.

Mr. C. L. Brook's list of 12 shooting-stars observed at Meltham includes two α Cygnids and some meteors from Perseus and Cassiopeia.

So much attention has been paid this year to the early Perseids that particular interest attaches to the following list of chief radiants for the period July 12 to 24, kindly supplied by Mr. Denning from his observations in past years:—

7 + 35	284 − 13	330 + 36
16 + 31	290 + 59	333 + 12
24 + 43	292 + 52	333 + 27
47 + 43	295 + 85	333 + 72
60 + 49	296 ± 0	334 + 58
105 + 51	303 + 24	335 + 49
245 + 72	303 + 52	339 − 13
255 + 37	304 − 12	347 ± 0
270 + 47	310 + 79	350 + 37
271 + 21	315 + 47	351 + 52
274 + 68	317 − 11	

AUGUST PERSEIDS.

It has been already remarked that moonlight interfered with the observation of the August Perseids in their customary numbers. Watches were kept, however, for a lengthy period in the aggregate, and a fairly connected record of the shower obtained.

August 1.—$11^h\ 18^m$, a meteor of magnitude $1\frac{1}{2}$ observed by the Rev. S. J. Johnson; $11^h\ 35^m$ to $12^h\ 20^m$, eight meteors, including about three from radiants in Perseus, mapped by Prof. Herschel.

August 3.—$9^h\ 30^m$ to $11^h\ 30^m$, one very bright Perseid and three small ones seen by Mr. Milligan.

August 4.—$9^h\ 20^m$ to 10^h and $10^h\ 25^m$ to 12^h, 23 meteors noted by Mr. Brook, chiefly in the second watch; three meteors during the evening by Mr. Astbury, one a Perseid of magnitude $1\frac{1}{2}$; $10^h\ 5^m$ to $12^h\ 5^m$, 16 meteors (three Perseids), by Mr. King, at Leicester; from 11^h to 12^h, three meteors by Mr. Scriven Bolton, at Leeds.

August 5.—$9^h\ 30^m$ to $11^h\ 30^m$.—No definite radiation of Perseids observed by Mr. Milligan; one Perseid by Mr. Astbury; $12^h\ 15^m$ to $12^h\ 30^m$, three meteors (one Perseid) by Prof. Herschel; two meteors after $12^h\ 38^m$ by Mr. Backhouse, at Sunderland.

August 7.—$9^h\ 10^m$ to $11^h\ 58^m$, 16 meteors (six Perseids), seen by Mr. Bridger; one large meteor from W. of Cassiopeia by Mr. Milligan.

August 8.—One Perseid recorded by Mr. Astbury.

August 9.—$10^h\ 25^m$ to $11^h\ 25^m$, one Perseid and one other meteor (magnitude $1\frac{1}{2}$), noted by the Rev. S. J. Johnson.

August 10.—9^h 30^m to 11^h 30^m, six Perseids by Mr. Milligan; a 1st magnitude Perseid by Mr. W. S. Tucker, at Williton; 10^h 18^m to 11^h 18^m, three non-Perseids by the Rev. S. J. Johnson; 10^h 50^m to 11^h 30, three Perseids and no other meteors by Mr. King; 11^h to 12^h, probably one Perseid in 20 minutes by Col. Markwick, at Devonport; 11^h 45^m to 12^h 30^m, a 2nd magnitude Perseid in Cassiopeia by Prof. Herschel.

August 11.—9^h 20^m to 11^h, 12 meteors (seven Perseids) seen by Mr. Bridger; 9^h 30^m to 11^h 30^m, eight Perseids by Mr. Milligan; 10^h 13^m to 11^h 13^m, three Perseids, one a greenish 1st magnitude meteor at 11^h 11^m, by the Rev. S. J. Johnson; 10^h 30^m to 12^h 15^m, eight meteors, including four from radiants in Perseus, by Prof. Herschel; 10^h 53^m to 11^h 45^m, eight Perseids, very swift and evanescent, one about 1st magnitude, by Col. Markwick.

August 12.—Possibly one Perseid, noted by Mr. Backhouse, at West Hartlepool, in a watch of 28 minutes; eight meteors in a short watch by Mr. Denning; 9^h 30^m to 11^h 30^m, 10 Perseids by Mr. Milligan; 10^h 20^m to 13^h, 19 meteors (16 Perseids) by Mr. King; 12^h 5^m to 12^h 50^m, seven meteors (four as bright as, or brighter than, 1st magnitude stars) by Prof. Herschel; a few Perseids during the evening by the Rev. S. J. Johnson.

August 13.—One very bright meteor E. of the cluster in the sword-hand of Perseus, seen by Mr. Milligan; 10^h 19^m to 10^h 56^m three meteors (one Perseid) by Mr. Bridger; 10^h 30^m to 11^h 30^m, five meteors by Prof. Herschel; 10^h 45^m to 11^h 30^m, one meteor by Mr. King.

Most observers seem to have discontinued watching for Perseids after this date, but Mr. Denning observed five meteors from centres close to the theoretical position of the Perseid radiant on each of the dates August 16 and 22, and there seems little doubt but that these were connected with the well-known shower itself.

As regards the meteors observed in the latter half of August, Mr. Denning registered 81 from August 15 to 30, these being distributed as follows:—August 15, 2 meteors; August 16, 11; August 17, 3; August 18, 5; August 19, 5; August 20, 2; August 22, 27 (37 in all were seen in about $3\frac{1}{4}^h$, from 10^h 7^m to 13^h 23^m); August 23, 3; August 24, 14 (seven others were not recorded); August 26, 7; August 30, 2. The most important showers represented were of β Piscids, η Pegasids, and β Cepheids. Six meteors were of the 1st magnitude, one as bright as Jupiter, and two as bright as Venus.

Mr. Brook, in two watches, on August 20 (from 9^h 35^m to 10^h 50^m, and from 11^h to 12^h) observed 17 meteors. At 10^h 5^m a momentary reddish flash of the 1st magnitude appeared at about $327\frac{1}{2}^\circ - 22^\circ$.

Mr. King saw 16 meteors between 11^h 5^m and 12^h 50^m on August 21, and 24 from 10^h to 12^h 30^m on August 22, registering 14 and 21 of these respectively. Two β Piscids, which appeared on August 22, with four earlier ones (on July 30 and August 4)

give a radiant-point at exactly the same position, 346° + 1°, as that found for the shower at Bristol.

A 1st magnitude meteor, probably a Cygnid, was recorded by the Rev. S. J. Johnson, at $10^h\ 52\frac{1}{2}^m$, on August 23, and four meteors were noted by Mr. Astbury, at Shifnal, between $9^h\ 30^m$ and $9^h\ 54^m$, on August 24.

SEPTEMBER METEORS.

On September 1 and 2, Mr. Denning watched for $2\frac{3}{4}^h$ each night, observing 22 and 21 meteors respectively. The principal shower was that of six ζ Cepheids. Mr. Denning has considered these early September meteors in conjunction with those recorded in the period August 15–30, and gives the radiants for the whole of the nights in question together. The Rev. S. J. Johnson observed a reddish meteor of the 1st magnitude, from a polar radiant, at $10^h\ 27^m$ on September 11, and a 1st magnitude ρ Boötid at $8^h\ 39\frac{1}{2}^m$, on September 19.

During this month Mr. Brook, at Meltham, recorded more than 60 meteors. Most of these were seen on September 17 ($1\frac{1}{2}^h$ between $9^h\ 58^m$ and $11^h\ 45^m$; 10 meteors), 18 (8^h to 10^h and $10^h\ 15^m$ to 11^h, 11 meteors; and September 19 (8^h to 10^h and $10^h\ 25^m$ to $11^h\ 15^m$, 20 meteors). The other nights of observation were September 13, 14, 15, 29, and 30, when 2, 3, 4, 6, and 6 meteors respectively were registered. On September 17 and 18 there were three η Cetids from a radiant at 23°–13°.

Mr. Bridger saw six meteors in watches from 8^h to $8^h\ 15^m$, and from $8^h\ 50^m$ to $9^h\ 45^m$ on September 25.

Seven meteors were observed by Mr. Denning on September 18, and one on the following evening. Up to $12^h\ 35^m$ on September 23, 17 were seen, and eight more on September 24, between about $8^h\ 40^m$ and $10^h\ 30^m$. He recorded nine shooting-stars on September 27, 16 on September 29, and 10 on September 30, making a grand total of 127 in $17\frac{1}{4}$ hours' watch on 10 nights. Cepheids were still appearing in the second half of the month. Mr. Bolton observed 11 meteors on the nights September 23 to 27, chiefly between 9^h and 10^h.

ORIONIDS.

During October Mr. Brook recorded 55 meteors. A few were seen on nearly every night between October 3 and 13, while on October 14, between $7^h\ 15^m$ and $8^h\ 45^m$, and also $9^h\ 45^m$ and $11^h\ 25^m$, 15 were noted. With three on the following night the total for the first half of the month was made up to 31. A δ Aurigid shower furnished two meteors on October 4, one on October 10, and two on October 14. Among the remaining shooting stars were two Camelopardids (77° + 73°) and two δ Geminids (103° + 26°), all on October 14.

Passing now to the Orionid period, it is found that the earliest meteor of this shower, of which record has been received, was observed by Mr. Brook at $10^h\ 46^m$ on October 17, leaving a streak for two or three seconds. This was during a watch of about $1^h\ 45^m$ between 9^h and 11^h, when nine meteors in all were seen. Two or three more Orionids were noted on October 21 among a

total of 13 shooting stars, between $7^h\ 30^m$ and $8^h\ 25^m$, and also $10^h\ 50^m$ and $12^h\ 20^m$. Some of the weaker showers represented during the month were of α Aurigids and α Ursæ Minorids.

Prof. Herschel observed an early Orionid on October 17, at $11^h\ 43\frac{1}{2}^m$. On October 20, from $12^h\ 30^m$ to 13^h, five meteors (of which one was an Orionid) were mapped. Between $11^h\ 30^m$ and $12^h\ 35^m$ on October 23 eight meteors were recorded, three being Orionids. Eleven more shooting stars were mapped on October 27 from $8^h\ 45^m$ to 11^h, but no further Orionids were seen. A bright meteor of the shower (magnitude $1\frac{1}{2}$) was noted by Mr. King at $17^h\ 50\frac{1}{2}^m$ on October 18.

Mr. Denning observed 141 meteors during watches which totalled $12\frac{3}{4}^h$ in October. Radiants for Orionids were separately deduced for October 23 and October 26 to 27, and these confirm the stationary character of the centre of the shower remarked in many years by Mr. Denning. The usual contemporary shower of γ Geminids was well marked.

Seven meteors were noted by Mr. Bolton between October 13 and 23 (chiefly on October 21 and 23). None of these was an Orionid. One was especially remarked for its red colour (October 23, $8^h\ 5^m$).

The last Orionid was the only one observed by Mr. Astbury during watches for a total of about five hours. It appeared at $10^h\ 9^m$ on October 25, its radiant being a little to the east of $92° + 15°$. The shower from $96° + 17°$ which is entered in the list of "Radiant Points" for October 21 (six meteors) was still in evidence on October 25.

Two meteors were glimpsed by Mr. Bridger between $8^h\ 55^m$ and $9^h\ 20^m$ on October 26. Five were recorded (nearly all from probable radiants in Aries or Taurus) and four glimpsed from $9^h\ 34^m$ to $10^h\ 30^m$ on the following night. On October 26 at $9^h\ 50\frac{3}{4}^m$, a meteor of magnitude $1\frac{1}{2}$ was observed in Perseus by the Rev. S. J. Johnson.

LEONIDS, TAURIDS, &c.

Those who expected a great shower of Leonids in mid-November were again disappointed. From the observations received the display seems to have been comparable only with the second-rate returns among those that have taken place since 1869.

Mr. H. G. Tomkins forwards a series of observations made by a party organised by him at Allahabad. Fifteen volunteers, almost all natives of India, were instructed in the work, first meeting for this purpose early in November. Watch was begun on November 8 between 14^h and 16^h, and continued during the same period on successive nights until November 13, 14, and 15, when watch was kept from $10^h\ 30$ till daylight. The details of the observations are as follows:—On November 8, 9, 10, and 11 the numbers of Leonids seen were 2, 0, 3, and 23* respectively. On November 12 no report was sent in.

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* Mr. Tomkins notes that another person saw only seven, and therefore he thinks meteors other than Leonids may have been included in this number.

OBSERVATIONS OF LEONIDS MADE AT ALLAHABAD, 1900.

Allahabad Time.	Number of Leonids.		
	November 13.	November 14.	November 15.
h m — h m			
10 30 — 11 15			0
11 15 — 11 20			1
11 20 — 12 10		0	0
12 10 — 12 15	0		1
12 15 — 12 20		1	
12 20 — 12 25		1	
12 25 — 12 30	1		
12 30 — 12 40		0	0
12 40 — 12 45		1	
12 45 — 13 45	0		
13 45 — 13 50			1
13 50 — 14 0		0	
14 0 — 14 5	1		
14 5 — 14 25	0		0
14 25 — 14 30	1	1	
14 30 — 14 35	0		1
14 35 — 14 40	2	0	2
14 40 — 14 50	0		
14 50 — 14 55	1	1	0
14 55 — 15 0		1	1
15 0 — 15 5		1	1
15 5 — 15 10		2	1
15 10 — 15 15		1	0
15 15 — 15 20			1
15 20 — 15 25	0	0	1
15 25 — 15 30		1	0
15 30 — 15 35		0	1
15 35 — 15 40		1	0
15 40 — 15 45			1
15 45 — 15 50	2	0	1
15 50 — 15 55		1	3
15 55 — 16 0	0	1	1
16 0 — 16 5	1	0	1
16 5 — 16 10	1	1	0
16 10 — 16 15	1	4	2
16 15 — 16 20	2	0	1
16 20 — 16 25	1	2	2
16 25 — 16 30		2	1
16 30 — 16 35	0	1	0
16 35 — 16 40	1	1	2
16 40 — 16 45		2	1
16 45 — 16 50		1	0
16 50 — 16 55		1	3
16 55 — 17 0		0	0
17 0 — 17 5	0	1	1
17 5 — 17 10		1	
17 10 — 17 15		2	0
17 15 — 17 20			1
17 20 — 17 30		0	0
17 30 — 17 35	—		—
Totals - -	15	33	33

On November 13 the sky was cloudy in the E. from $10^h\ 30^m$ till about 13^h; it was also flecked with clouds towards dawn. On November 15, clouds came up about $12^h\ 20^m$, and from 13^h to $13^h\ 40^m$ the sky was very much overcast. After that time it cleared up.

The greatest number of meteors that appeared in any five minutes was four from $16^h\ 10^m$ to $16^h\ 15^m$, on the night of November 14, against seven from $16^h\ 45^m$ to $16^h\ 50^m$, on that of 1899, November 14, and 20 from $16^h\ 15^m$ to $16^h\ 20^m$ on that of 1898, November 15.

From the above table it is evident that, as far as India is concerned, the maximum of the shower occurred between 16^h and 17^h on November 14.

Prof. Herschel recorded 10 meteors on November 9, chiefly between 13^h and $14^h\ 30^m$. On November 13 seven meteors were seen between $7^h\ 45^m$ and $10^h\ 45^m$, and 23 between $12^h\ 20^m$ and $17^h\ 30^m$. Only three good Leonids were included in this number—at $13^h\ 32\frac{1}{2}^m$, $13^h\ 55\frac{1}{2}^m$, and $14^h\ 21^m$—but there were two rather dubious ones—at $15^h\ 39\frac{1}{2}^m$ and $17^h\ 11\frac{1}{2}^m$—and a wide one, probably—at $15^h\ 58^m$. On November 15 eight meteors were observed between $13^h\ 25^m$ and $13^h\ 45^m$, and on November 16 four between $10^h\ 40^m$ and about $11^h\ 40^m$.

Mr. E. C. Willis has forwarded a report of his observations, made at Norwich, from which he concludes that the maximum decidedly occurred on November 13. He also draws attention to the absence of Leonids between $17^h\ 30^m$ and 18^h on the same night, and particularly to the great dearth of these meteors on November 15. The number of Leonids and other meteors appearing in each of his extensive watches were as follows:—

Watch.	Leonids.	Other Meteors.	Watch.	Leonids.	Other Meteors.
d h m — h m			d h m — h m		
9 16 30 — 17 0*	0	5	14 13 0 — 13 15*	4	5
17 0 — 18 0*	0	0	13 15 — 13 30*	0	5
10 16 30 — 17 0*	0	2	13 30 — 13 45*	3	2
17 0 — 17 30*	1	3	13 45 — 14 0*	3	3
17 30 — 18 0*	2	4	14 0 — 14 15*†	1	1
11 16 30 — 17 0*†	0	4	14 15 — 14 25*†	1	1
17 0 — 17 30*†	2	3	16 0 — 16 15*†	0	1
12 Cloudy; no observations.			17 15 — 17 25*†	0	0
13 15 15 — 15 30*†	4	0	15 11 15 — 11 30	0	6
15 30 — 15 45*†	4	1	11 30 — 11 45	0	3
15 45 — 16 0*	1	3	11 45 — 12 0	0	2
16 0 — 16 15*†	0	0	12 0 — 12 15†	0	9
17 0 — 17 15*†	3	1	15 0 — 15 15*†	0	3
17 15 — 17 30*†	4	2	15 15 — 15 30*†	0	1
17 30 — 17 45*	0	0	15 30 — 15 45*†	0	0
17 45 — 18 0*	0	4	15 45 — 16 0*	2	4
14 11 15 — 11 30†	0	1	16 0 — 16 15*	0	2
12 0 — 12 15	0	4	16 11 30 — 11 45	0	5
12 15 — 12 30*	2	1	11 45 — 12 10†	0	5
12 30 — 12 45*	2	6	12 15 — 12 30	0	6
12 45 — 13 0*	3	2			
Total - -	- -	- -	12 15	42	110

* Moon above horizon. † Some clouds.

On November 12 Mr. Brook registered two meteors, and on the following night 10, chiefly in a watch of 2^h 40^m between 15^h 15^m and 18^h 10^m. Three other faint meteors were from a radiant not far from θ Ursæ Majoris. Outlook was kept at intervals on the latter night from 11^h, but the only Leonids seen were five in about the last two hours of watch.

On November 12, at 9^h 28^m, Mr. T. W. Backhouse, at Sunderland, observed a meteor as bright as Sirius. Seven Leonids were seen on the succeeding nights, as follows:—November 13, 16^h 31^m; November 15, 14^h 3^m, 14^h 34^m, 15^h 20^m, 15^h 50^m, 16^h 9^m, and 16^h $9\frac{1}{2}^m$. In all, 19 meteors were noted in a total watch, discounted for clouds, of about $4\frac{1}{2}^h$.

Watches were much interrupted by clouds at Bristol, as at many other places. Mr. Denning found Taurids more numerous than Leonids on November 13 and 14. On the former night 17 meteors were recorded in four watches after 10^h and up to nearly 18^h. This number included three Leonids, all appearing between 12^h 59^m and 13^h 32^m. Three shooting stars only were seen on the second night, one being a Leonid and one a Taurid.

On November 15, Mr. Astbury kept watch from 11^h 25^m till 13^h 45^m, registering 17 meteors, including six Leonids. Three shooting-stars were from a radiant at $60° + 12°$, near γ Tauri. He compares the Leonids referred to above with those seen on 1899, November 14, from 16^h onwards, thus:—"Those "seen in 1899 were on the average brighter than magnitude 2, "intensely white, with beautiful streaks of a greenish blue "colour; those of the present watch averaged about magnitude "3, were reddish-yellow, and none of them exhibited anything "like the phosphorescent streaks seen in 1899."

On November 14, the Director kept watch at Westminster from 11^h 26^m to 12^h 15^m, and at Clapham from 13^h to 14^h 15^m. Two and six meteors respectively were recorded, the first four being of the 1st magnitude or brighter. The second, at 12^h 1^m, was a long-pathed orange Leonid, and another meteor of the shower appeared at 13^h 20^m. Between 12^h and 14^h 30^m, on November 15, 16 meteors were observed. Four were Leonids, while among the meteors of the two nights, two were δ Geminids ($110° + 22°$), and one was a Taurid from about $57° + 9°$.

The following observations were made by Mr. King, at Rearsby, about $7\frac{1}{2}$ miles N.E. of Leicester. Between 12^h 30^m and 16^h 45^m, on November 15, 18 meteors (six Leonids) were seen, and, of these, 13 meteors (three Leonids) recorded. He found that the maximum occurred between 14^h 30^m and 15^h. Watches had been kept on November 10, from 17^h 25^m to 18^h 15^m, and on November 13, from 17^h to 17^h 30^m, but without success.

Mr. C. B. Holmes commenced observations at East Barnet, at about 12^h 30^m on November 15, and mapped 13 meteors. From his diagram, seven of these appear to have been Leonids. The watch was terminated at 14^h, having been kept for 40 minutes in the absence of clouds.

The Rev. W. R. Waugh, at Portland, and the Rev. S. J. Johnson, at Bridport, did not observe any Leonids on account of clouds and fog. The former, however, saw a fine meteor, probably a Taurid, on November 16 at 10^h 30^m, about the size of

Castor, over which star it passed from θ Geminorum to near ψ Cancri. On November 18, at about 10^h, a few small meteors were seen which seemed to be Taurids.

During the latter half of November another disappointment was experienced, this time with regard to the Andromedids.

On November 17, at $5^h\ 49^m$, the Rev. S. J. Johnson recorded a blood-red meteor of the 1st magnitude, passing very swiftly from $45° + 41°$ to $17° + 7°$.

Mr. Astbury observed 13 meteors in the period November 18–27. Five of these appeared between $7^h\ 45^m$ and $9^h\ 4^m$ on November 22, and included one Andromedid. On Novembor 27 a second Andromedid was noted.

On November 22, 23, and 27, two, two, and six meteors respectively were recorded by Mr. King, at Leicester. The total length of the watches was 3^h, but no Andromedids were seen.

On November 23, during $1^h\ 38^m$ of clear sky between $7^h\ 55^m$ and $10^h\ 8^m$, five meteors were observed, and three more glimpsed by Mr. Bridger. From $8^h\ 55^m$ to $10^h\ 22^m$ ($1^h\ 15^m$ clear) on November 27 the numbers were five and two. Two or three of these meteors were Taurids or Aurigids, and one was a nearly stationary Geminid at about $102° + 31°$.

Prof. Herschel recorded four shooting stars in $1\frac{1}{2}^h$, $7^h\ 30^m$ to 9^h, and seven in $1\frac{3}{4}^h$, $10^h\ 15^m$ to 12^h, on November 23. In three watches for an aggregate length of 2^h between $6^h\ 50^m$ and 10^h on November 25, 10 meteors were observed, and eight in three watches for $3\frac{1}{4}^h$ in all between $7^h\ 45^m$ and $11^h\ 50^m$ two nights later. Prof. Herschel notes that the whole, or very nearly the whole, of the active Taurid radiation of 1900 was produced, according to his observations, by the centres $57° + 18°$ (one meteor on October 23, seven on November 9–15, and two on November 23), and $57° + 9°$ (10 or 11 meteors, October and November). The principal among a large number of radiants deduced from the observations of November 9–27 are given in the list of "Radiant Points."

GEMINIDS.

During a total watch of 41 minutes on December 9, Mr. Backhouse observed two meteors, of which one was a Geminid. Two evenings later, in a watch of about the same length (free from cloud), four meteors (three Geminids) were seen. Again, on December 12 for about an hour, at intervals between $7^h\ 30^m$ and $11^h\ 10^m$ watch was kept, the resulting number of meteors being 12 (seven Geminids). During a similar watch on the following night 10 meteors (eight Geminids) appeared, and the last Geminid was seen at $9^h\ 53^m$ on December 15. In all 29 meteors (20 Geminids) were noted in watches amounting to $5^h\ 20^m$ ($4^h\ 43^m$ free from cloud). The magnitudes of the shooting-stars were of high average, as under:—

Magnitudes -	= Sirius	0	1	2	3	4	5	
Geminids - -	1	—	7	6	2	3	1	= 20
Other meteors -	1	1	2	1	2	—	2	= 9

Between 9^h and 10^h and $10^h\ 30^m$ and 12^h on December 11 Mr. Brook recorded 13 meteors (about seven from radiants in

Gemini). Six other meteors, of which four were Geminids, were not registered, while two were observed on the preceding night. In all there were about 11 Geminids. On December 12 the watches kept were from 8^h to 9^h 20^m, and from 10^h 10^m to 12^h 15^m (3^h 25^m). Of the 17 meteors registered, 10 were Geminids, and of eight shooting-stars unrecorded, seven belonged to these showers. The Geminid maximum appeared to be between 10^h 51^m and 11^h 35^m, when 13 of these meteors were seen. The centre of the principal radiation-area was at about $111° + 31\frac{1}{2}°$, a place closely agreeing with the mean position of that of the main shower at this period.

At Leicester Mr. King watched from 10^h 30^m to 11^h on December 11, recording two meteors out of four seen in all. Neither of these was a Geminid. Between 10^h 10^m and 11^h on December 13, five meteors, including three Geminids, were registered. The same number of meteors was seen in a watch from 10^h 50^m to 12^h 5^m on December 15, but this comprised no Geminids. One meteor was as bright as Sirius, and four others more brilliant than 1st magnitude stars.

On December 13, between 8^h 10^m and 9^h, Mr. Astbury registered 14 meteors, 12 of which were Geminids. Another watch from 9^h 50^m to 10^h 30^m (about 25 minutes) yielded three more Geminids. He remarks that the shower, which, earlier in the evening had seemed unusually active, had decidedly declined. Several other meteors, evidently Geminids, were seen, but not sufficiently well to record. One meteor was brighter than, and six equal to, the 1st magnitude.

Prof. Herschel mapped 27 meteors in five hours' watch on December 13, 15, 19, and 21. On the first date 18 were observed, three being γ Geminids ($99° + 13°$)—*see* also table of "Radiant Points."

Radiant Points of Meteoric Showers, 1900.

B.A.A. Ref. No.	Date.	Name.	Radiant Point.	No. of Meteors.	Class.	Observer.
	1900.		$\alpha°$ $\delta°$			
926	Jan. 2	Quadrantids	230 + 50	7	M	T. H. A.
927	„ 2	„	230 + 54	13	M	W. E. B.
928	„ 2	50 Cassiopeids	22 + 67	4	R	W. E. B.
929	Mar. 20–30	ψ Ursids	163 + 46½	4	M	J. H. B.
930	„ 29–Apr. 19	ζ Ursids	205 + 52	4	M	A. K.
931	Apr. 19–21	ζ Bootids	221 + 20	4	M	J. H. B.
932	„ 20–21	97 Herculids	266 + 26	5	M	A. K.
933	„ 20–21	Lyrids	273 + 34	8	RK	J. H. B.
934	„ 20–21	„	274 + 33	8	RK	A. K.
935	„ 20–23	η Draconids	237 + 58	4	M	J. H. B.
936	July 15–18	α Aquilids	304 + 4	5	M	W. F. D.

B.A.A. Ref. No.	Date.	Name.	Radiant Point.	No. of Meteors.	Class.	Observer.
	1900.		α° δ°			
937	July 15–30	γ Andromedids	24 + 43	7	RK	W. F. D.
938	„ 15–30	o Draconids	291 + 59	6	S	W. F. D.
939	„ 15–30	θ Cygnids	291 + 52	8	S	W. F. D.
940	„ 15–30	α Capricornids	305 − 12	8	SL	W. F. D.
941	„ 15–30	α Cynids	316 + 48	9	S	W. F. D.
942	„ 15–30	β Cepheids	335 + 73	5	R	W. F. D.
943	„ 15–30	δ Aquarids	338 − 10	24	SL	W. F. D.
944	„ 17, and 30–31	„	339 − 12	5	—	A. S. H.
945	„ 18–24	ϵ Sagittids	297 + 14½	4	VR	W. E. B.
946	„ 18 and 28–Aug. 1.	χ Perseids	34 + 56	4	—	A. S. H.
947	„ 19–24	α Aquilids	302 + 3	11	R	W. E. B.
948	„ 19–25	ϕ Andromedids	16 + 48	4	VR	A. S. H.
949	„ 20–25	ν Andromedids	11 + 41	5	—	A. S. H.
950	„ 23	Perseids	23 + 51	5	RK	W. E. B.
951	„ 23–24	„	24 + 50	5	—	A. S. H.
952	„ 23–24	κ Aquilids	292 − 10	7	S	W. E. B.
953	„ 23–Aug. 1	44 Piscids	7 + 6	4	—	A. S. H.
954	„ 24	Perseids	25 + 52½	7	RK	W. E. B.
955	„ 24	δ Cygnids	289½ + 42	4	R	W. E. B.
956	„ 24–26	4 Lacertids	335 + 48	5	RB	W. H. M.
957	„ 24–30	δ Cassiopeids	12 + 62	5	RK	J. H. B.
958	„ 29, and Aug. 4, 12.	γ Andromedids	22 + 44	5	VR	A. K.
959	„ 30	α Cassiopeids	5 + 50	5	—	W. H. M.
960	„ 30	Perseids	30 + 54	4	—	E. M. A.
961	„ 30	„	31 + 54	10	RK	W. F. D.
962	„ 30–Aug. 1	Perseids	33 + 54½	4	RK	J. H. B.
963	„ 30, and Aug. 4, 22.	β Piscids	345 + 1	6	S	A. K.
964	Aug. 7	Perseids	39 + 54	5	RK	J. H. B.
965	„ 11	„	43 + 56½	6	RK	J. H. B.
966	„ 12	„	48 + 58	12	RK	A. K.
967	„ 14	„	50 + 56	5	—	E. M. A.
968	„ 15–26	α Cepheids	312 + 59	5	S	W. F. D.
969	„ 15–26	η Pegasids	333 + 28	11	S	W. F. D.
970	„ 15–26	β Cassiopeids	356 + 60	5	R	W. F. D.
971	„ 16	Perseids	54 + 58	5	RK	W. F. D.
972	„ 16–18	o Draconids	291 + 60	5	S	W. F. D.
973	„ 16–Sept. 2	β Aurigids	89 + 42	5	VRK	W. F. D.
974	„ 18–30	β Piscids	346 + 1	12	R	W. F. D.

B.A.A. Ref. No.	Date.	Name.	Radiant Point.	No. of Meteors.	Class.	Observer.
	1900.		α° δ°			
975	Aug. 20–26 -	β Cepheids -	335 + 71	9	S	W. F. D.
976	„ 22 -	Perseids -	59 + 59	5	RK	W. F. D.
977	„ 22–Sept. 1	η Sagittids -	304 + 21	4	S	W. F. D.
978	„ 22– „ 2	α Camelopardids.	71 + 65	6	R	W. F. D.
979	Sept. 1–2 - -	ζ Cepheids -	334 + 57	6	S	W. F. D.
980	„ 14–29 -	δ Cepheids -	338 + 56	5	R	C. L. B.
981	„ 17–19	ζ Perseids -	50 + 24	4	R	C. L. B.
982	„ 18–19 -	β Arietids -	18 + 20	4	R	C. L. B.
983	„ 19–30 -	ϵ Piscids -	10 + 10	4	S	C. L. B.
984	„ 23–30 -	γ Pegasids -	6 + 11	—	S	W. F. D.
985	„ 23–30 -	α–β Perseids -	47 + 42	—	M	W. F. D.
986	„ 23–30 -	α Camelepardids.	72 + 65	—	R	W. F. D.
987	„ 23–30 -	ι Aurigids -	76 + 32	—	—	W. F. D.
988	„ 23–30 -	ζ Cepheids -	332 + 55	—	R	W. F. D.
989	Oct. 4–14 -	δ Aurigids -	89 + 64	5	R	C. L. B.
990	„ 15–21 -	ξ Arietids -	35 + 9	5	M	C. L. B.
991	„ 17–21 -	Orionids -	93 + 15	4	VRK	C. L. B.
992	„ 17–23 -	„ -	90 + 15	5	RK	A. S. H.
993	„ 21 - -	γ Geminids -	96 + 17	6	MLB	T. H. A.
994	„ 23 - -	Orionids -	92 + 15	5	RK	W. F. D.
995	„ 23–27 -	σ Arietids -	43 + 12	8	R	W. F. D.
996	„ 23–27 -	56 Arietids -	45 + 27	8	R	W. F. D.
997	„ 23–27 -	α–β Perseids -	47 + 43	6	S	W. F. D.
998	„ 23–27 -	e Taurids -	57 + 9	6	M	W. F. D.
999	„ 23–27 -	β Canis Minorids.	99 + 13	10	RK	W. F. D.
1000	„ 26–27 -	Orionids -	91 + 16	5	RK	W. F. D.
1001	„ 26–27 -	31 Lyncids -	123 + 42	4	RK	W. F. D.
1002	„ 27 -	δ Cepheids -	337 + 57	—	S	T. H. A.
1003	Nov. 9–27 -	δ Cassiopeids	8 + 56	5	—	A. S. H.
1004	„ 9–27 -	Andromedids	23 + 43	4	—	A. S. H.
1005	„ 9–27 -	ϵ Arietids -	44 + 24	5	—	A. S. H.
1006	„ 9–27 -	ζ Eridanids -	46 − 5	5	—	A. S. H.
1007	„ 9–27 -	ζ Perseids -	56 + 28	6	—	A. S. H.
1008	„ 9–27 -	γ Eridanids -	57 − 7	7	—	A. S. H.
1009	„ 9–27 -	e Taurids -	57 + 9	6	—	A. S. H.
1010	„ 9–27 -	ϵ Taurids -	57 + 18 64 + 23	13	—	A. S. H.
1011	„ 9–27 -	ϵ Perseids -	58 + 38	6	—	A. S. H.

B.A.A. Ref. No.	Date.	Name.	Radiant Point.	No. of Meteors.	Class.	Observer.
	1900.		α° δ°			
1012	Nov. 9–27	ι Aurigids	70 + 35	4	—	A. S. H.
1013	„ 9–27	ζ Taurids	80 + 18	4	—	A. S. H.
1014	„ 9–27	δ Canis Majorids.	104 − 20	5	—	A. S. H.
1015	„ 9–27	μ Leonids	145 + 28	4	—	A. S. H.
1016	„ 9–27	Leonids	150 + 21	4	VRK	A. S. H.
1017	„ 9–27	β Leonids	177 + 9	4	—	A. S. H.
1018	„ 13	Leonids	148 + 23	4	VR	C. L. B.
1019	„ 13–14	γ Taurids	58 + 10	6	ST	W. F. D.
1020	„ 13–14	Leonids	151 + 22	4	RK	W. F. D.
1021	„ 14–15	56 Arietids	48 + 22½	4	S	W. E. B.
1022	„ 14–15	Leonids	150 + 22	6	RK	W. E. B.
1023	„ 15	„	151 + 23	6	R	T. H. A.
1024	„ 15	„	151½ + 22	3	VR	A. K.
1025	„ 27–Dec. 11	ϵ Taurids	69 + 23	4	R	A. K.
1026	Dec. 12	Geminids	111 + 31½	6	R	C. L. B.
1027	„ 13	„	104 + 35 110 + 29	7	—	A. S. H.
1028	„ 13 (and 1899, Dec. 8).	„	109 + 31	4	—	A. K.
1029	„ 13	„	109 + 35 113 + 32	12	R	T. H. A.

In column 6—B = Bright; K = Streaked; L = Long-pathed; M = Of moderate velocity; R = Rapid, swift; S = Slow; V = Very.

The Fireballs of 1900.

Brilliant meteors were numerous during the year, and presented many features of interest. Perhaps the most remarkable was the daylight fireball of January 9, $2^h\ 55^m$. This object was observed from several places in Surrey, West Kent, and Mid-Sussex, as well as from London and Dunstable. It travelled from west to east, and, fortunately, the moon was in such a position that the place of the meteor could be easily referred to it.

The brilliant flash at the disappearance of a fireball at $8^h\ 32^m$ on March 28 was noted by Mr. Astbury, who, however, did not see the meteor itself. From descriptions of observers he found the course to have been from 188° + 18° to 193° − 6°. Mr. Crommelin, at Blackheath, observed it travelling from the direction of ϵ Ursæ Majoris, and bursting about 1° north of β Leonis; it was three times as bright as Venus. The fireball was also seen by Mr. G. T. Davis, at Reading, very near Cor Coroli, from which star it travelled towards β Leonis, but described a curve ending

near ϵ Virginis, and by Mr. G. M. Knight, at Bishop's Stortford, who heard a faint, though distinct, report at the end of an interval estimated at 11·8 seconds after the disappearance.

Several observers, chiefly in the Midlands, noted a meteor of great brilliancy in the twilight sky of May 5, at $8^h\ 20^m$. It travelled slowly from E. to W., and was much brighter than Venus.

Another twilight fireball appeared on June 10, at $9^h\ 10^m$. Lieut.-Col. J. P. H. Boileau, M.D., observed this object from Trowbridge, moving from N.E. to W., at an angle of about 30°, passing about 15° above Venus. It was also seen at Cardiff, Colwyn Bay, Spilsby, and other places.

On July 17, at $8^h\ 47^m$, a very brilliant fireball appeared. The Rev. L. D. Evans, on board ship in the North Sea, likened the trail to a huge river, which continued for upwards of an hour. The fireball was an α Scorpiid, one of a shower which has produced many such objects, chiefly in the period June to August.

On July 24, at $10^h\ 49^m$, a brilliant meteor was fortunately seen by several regular meteor-observers, thus :—

Path.		Brightness.	Velocity.	Observer.
From.	To.			
α δ	α δ			
6° + 21°	22° + 25½°	4	VS	W. F. D.
7 + 34½	26 + 37	4	M; 2½ secs.	T. H. A.
12 + 19	24½ + 25	4	S	A. K.
26 + 44	45 + 44½	♀	S; 2 secs.	J. H. B.

It was also seen, brighter than Venus, by Mrs. E. Besley, Clapham, passing from 35° + 52° to 55° + 42° with a slow motion and followed by a train of sparks.

A daylight fireball was widely observed on September 2, at $6^h\ 54^m$. Mr. W. Arthur Smith forwarded several accounts. As seen from Criccieth, it fell towards the north-east. At St. Anne's, the meteor was noted to leave a column of white smoke, covering an angle of quite 5°, which was visible for over 10 minutes.

On October 21, at about $8^h\ 35½^m$, there appeared a fireball which has been described, without authority, as the most brilliant that has been seen for many years. This was followed by other bright objects at about $8^h\ 44^m$ and $9^h\ 25^m$ (*see* the "Journal," Vol. XI., page 115).

Such were the features of some of the more important fireballs of the year. It is greatly to be regretted that many accounts of these and similar objects are very indefinite, incomplete, and even incorrect in character, but this can only be expected when the descriptions emanate from those who have little or no experience in astronomical work, and should encourage regular observers to take particular note of any brilliant meteors they may remark, so that the discrepancies referred to may be counteracted.

REAL PATHS OF FIREBALLS AND SHOOTING STARS OBSERVED AT TWO OR MORE STATIONS IN 1900.
Calculated by W. F. DENNING.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1900.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
Jan. 2	6 41	3	69	60	35	24	Saffron Walden -	10 miles N.W. South-end.	229 + 52	*Quadrantid.*	J. H. B.; T. H. A.
„ 2	11 58½	>1	57	40	44	22	Standon, Herts -	Staines - -	228 + 53	*Quadrantid.*	A. S. H.; W. E. B.
„ 9	2 55	Fireball in sunshine.	59	23	174	—	10 miles E. Valognes, France.	Calais - -	280 − 12	λ *Aquilid*	10 observers.
„ 25	11 10	3—1	65	44	26	30	Atherstone - -	Rugby - -	45 + 62	*Camelopardid.*	A. S. H.; J. H. B.
„ 27	11 10	1½—1	57	45	28	14	5 miles S.S.W. Rugby	3 miles W. Leicester	98 − 10	α *Canis Majorid.*	A. S. H.; A. K.
Mar. 28	10 33	3—2	54	50	13	29	Aylesbury - -	8 miles E. Oxford -	255 + 21	δ *Herculid*	A. S. H.; J. H. B.; A. K.
„ 28	10 45	2—1	56	40	16	16	Wendover - -	Wendover - -	179 + 47	ψ *Ursid*	A. S. H.; J. H. B.; A. K.
„ 28	11 29	3—2	73	65	18	36	4 miles E. Bicester -	Woodstock - -	252 + 22	δ *Herculid*	A. S. H.; J. H. B.
April 20	11 43	1	70	63	53	35	6 miles N. Norwich	North Sea - -	210 − 31	θ *Centaurid*	A. S. H.; J. H. B.; A. R. Hinks.
„ 21	9 54	2½—2	53	51	15	30	Witney - -	Stow, Glos. -	218 − 27	*Hydrid*	A. S. H.; T. H. A.
„ 21	10 4	3—2	113	71	73	94	Norwich - -	Royston - -	267 + 46	γ *Draconid*	A. S. H.; J. H. B.; T. H. A.
„ 21	10 32	3½—2	60	54	50	17	Bicester - -	Leicester - -	188 − 32	β *Corvid*	A. S. H.; J. H. B.; A. K.
„ 21	10 37	3	54	52	25	28	Chesham - -	Bletchley - -	218 − 31	*Hydrid*	A. S. H.; J. H. B.
May 3	13 58	5—2	54	49	155	28	Sevenoaks - -	9 miles S.W. Cardiff	337 ± 0	γ *Aquarid*	A. S. H.; J. H. B.
„ 5	8 20	Fireball	64	43	112	20	Canterbury - -	Hungerford -	245 + 5 (about)	λ *Ophiuchid.*	15 observers.

June	10	9 10	Fireball	65	28	55	32	Lampeter - -	Worms Head -	336 + 73	β *Cepheid*	9 observers.
July	15	10 13	>1—2×♀	51	21	78	16	Warrington -	Ravenglass -	297 − 11	α *Capricornid.*	C. L. B.; H. J. Townshend; W. F. D.
„	17	8 47	Fireball	58	15	175	Slow	Pickering - -	North Sea - -	249 − 20	α *Scorpiid*	15 observers.
„	18	11 33	4—♀	48	24	28	7	Sudbury - -	Colchester - -	240 + 70	γ *Ursæ Minorid.*	A. S. H.: H. Campbell; G. M. Knight.
„	19	11 40	>1—4	81	54	43	35	Odiham - -	10 miles E. Salisbury.	17 + 50	*Perseid*	A. S. H.; W. F. D.
„	23	11 13	2—1	83	59	49	30	10 miles E.N.E. Oxford.	3 miles W. Marlborough.	30 + 47	θ *Perseid*	A. K.; W. F. D.
„	23	12 12	2—1—♀	84	55	44	59	Sevenoaks - -	Pulborough -	24 + 52	*Perseid*	A. S. H.; W. E. B.; W. F. D.
„	23	13 1	2—4	67	66	51	85	20 miles S.S.E. Brighton.	15 miles S.E. Ventnor.	54 + 9	*Taurid*	W. E. B.; W. F. D.
„	24	10 42	3—2	72	63	28	12	5 miles S. Newport, Mon.	Crickhowell -	305 − 17	α *Capricornid.*	A. K.; W. F. D.
„	24	10 49	4—3×♀	68	27	103	19	Burnham, Essex -	Wells, Norfolk -	280 − 15	λ *Aquilid*	T. H. A.; J. H. B.; A.K.; W. F. D.; and others.
„	24	12 17½	4—1	78	71	39	49	8 miles W. Tunbridge Wells.	4 miles W.S.W. Chobham, Surrey.	14 − 6	*Cetid*	W. E. B.; W. F. D.
„	25	11 10	3—1	75	48	46	Swift	Thetford - -	10 miles N.W. Cambridge.	8 + 39	ν *Andromedid.*	A. S. H.; W. F. D.
„	28	11 46	3—1	65	44	52	29	5 miles N.W. Whitchurch, Salop.	15 miles W.S.W. Southport.	337 − 10	δ *Aquarid*	A. S. H.; W. F. D.
„	28	12 35	4—3	84	76	32	40	6 miles E. Swindon	Stroud - -	16 − 5	*Cetid*	A. S. H.; W. F. D.
„	30	10 46	Fireball	95	50	92	Swift	English Channel -	English Channel -	30 + 52	*Perseid*	5 observers.
„	30	11 45	3—2	56	40	52	35	6 miles W. Cambridge.	4 miles W. Stamford	338 − 10	δ *Aquarid*	A. S. H.; W. F. D.
Aug.	19	10 36	3×♀	56	29	62	Slow	East Coast of Ireland.	East Coast of Ireland.	346 + 1	β *Piscid*	Rev. T. E. R. Phillips; W. F. D.; and others.
„	22	10 8	2—4	75	50	25	25	Stamford - -	Stamford - -	310 + 53	α *Cygnid*	A. K.; W. F. D.

Real Paths of Fireballs and Shooting Stars observed at Two or more Stations in 1900—*continued.*

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1900.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
Sept. 2	6 54	Fireball	85	20	84	—	Richmond, Yorks. -	Fleetwood - -	334 + 57	ζ *Cepheid*	37 observers.
„ 16	8 44	>♀	50	32	86	—	Bewdley - -	Wigan - -	324 − 25	*Capricornid.*	T. Harries; W. E. B.; and others.
Oct. 21	8 35	Fireball	68	20	66	11	Near New Radnor -	Shifnal - -	300 + 22	η *Sagittid*	Many observers.
„ 21	11 58	♀	63	48	37	25	North Sea—Lat. 53° 20′ N.; Long. 2° E.	North Sea—Lat. 53° 42′ N.; Long. 2½° E.	350 − 4	*Piscid*	A. S. H.; C. L. B.
„ 23	12 29	3	96	81	31	44	5 miles N.E. Brightlingsea.	2 miles E. Great Bardfield.	99 + 13	ξ *Ursid*	A. S. H.; W. F. D.
„ 23	12 30	3—2	87	52	52	35	Slough - -	Woodstock -	74 + 14	ο *Orionid*	A. S. H.; W. F. D.
„ 27	9 51	4—2	73	60	58	40	5 miles N.E. Cambridge.	4 miles N.E. Croydon.	169 + 49	χ *Ursid*	A. S. H.; J. H. B.; W. F. D.
„ 27	11 42	>♀	76	67	34	40	5 miles W. Basingstoke.	8 miles S. Salisbury	136 + 34	ι *Cancrid*	Mrs. W. H. S. Monck; W. F. D.
Nov. 13	10 18	3½—1	68	57	18	25	4 miles W. Southampton.	3 miles E. Salisbury	58 + 7	*Taurid*	A. S. H.; W. F. D.
„ 13	13 32	2	69	58	24	48	Near Wallingford -	Near Swindon -	150 + 22	*Leonid*	A. S. H.; W. F. D.
„ 13	15 58	2½—1½	85	58	33	47	5 miles N. Hitchin -	Olney - -	145 + 29	μ *Leonid*	A. S. H.; J. C. W. H.
„ 27	11 10	Small fireball.	57	17	40	19	Ilfracombe - -	Bristol Channel -	47 + 45	α-β *Perseid*	A. S. H. and others.
Dec. 13	10 18½	>1	59	44	24	—	5 miles E. Hertford	2 miles E. Luton -	109 + 24	δ *Geminid*	T. H. A.; A. K.

Real Paths of Fireballs and Shooting Stars observed at Two or more Stations in 1899–1900.
Calculated by Prof. A. S. Herschel.

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1899.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
Aug. 9	11 58	2 —1	69	58	22	26	Newbury, Berks -	Andover, Hants -	76 + 59	β (or *d*) *Camelopardid.*	W. F. D.; A. S. H.
Nov. 13	15 13	3 —2	61	54	31	44	S. of Seaford, Sussex	Cuckfield, Sussex -	130 — 20 (or 128—19)	*Vela Navid*	J. H. B.; A. S. H.
1900.											
*Jan. 2	6 41	3	92	82½	30	25	Bury St. Edmunds	Colchester - -	230 + 53	*Quadrantid*	T. H. A.; J. H. B.
* „ 27	11 10	1½—1	55½	45	22½	13	S.S.W. of Rugby -	S.W. of Leicester -	98 — 10	α *Canis Majorid.*	A. K.; J. H. B.; A. S. H.
Mar. 28	8 31	Fireball	60	38	34	—	Folkestone - -	6 miles S. Ashford -	182 + 41	β (*d*) *Canum Venaticid.*	5 observers.
* „ 28	11 29	3 —2	59	53	13½	27	Brill, near Thame (or 7 miles S.E. Bicester).	Woodstock, Oxon. -	252 + 22	δ *Herculid*	J. H. B.; A. S. H.
Apr. 15	9 44	1	47	47	45	34	Alton, Hants - -	Bournemouth -	281 + 20 (about)	K *Cerberid*	Rev. S. J. Johnson; A. S. H.
„ 19	12 53	2	76	56	33	82	Fakenham, Norfolk	The Wash, E. of Boston.	231 + 23	K *Cerberid*	A. R. Hinks; J. C. W. H.; A. S. H.
„ 20	9 36	4 —3	60	59½	16½	18½	Dorking - -	Staines - -	206 — 31	θ *Centaurid*	J. H. B.; A. S. H.
„ 20	10 18	5 —3	33½	30	5½	18	N.W. of Basingstoke	N.W. of Basingstoke	257 + 40	π *Herculid*	H. Corder; A. S. H.
† „ 20	11 10½	2 —1	64	52½	11½	18	6 miles W.S.W. Market Harborough.	6 miles W. Market Harborough.	195 + 45	α *Canum Venaticid.*	J. H. B.; A. S. H.
* „ 20	11 43	1	69	58	41	27	Cromer - -	30 miles N. by W. Cromer.	222 — 21 (or 214—30)	γ *Librid*	A. R. Hinks; J. H. B.; A. S. H.
‡ „ 21	9 45	3 —2	41	38	5½	35 (about)	N.E. of Witney -	N.E. of Witney -	222 + 18	ξ *Boötid*	T. H. A.; A. S. H.
* „ 21	9 54	2½—2	49	48½	13½	27	Burford, Oxon. -	Stow, Glos. - -	219 — 29	θ *Centaurid*	T. H. A.; A. S. H.
* „ 21	10 4	3 —2	94	70	47	59	Ixworth, Suffolk -	Royston - -	270 + 40 (about)	*Lyrid*	J. H. B.; T. H. A.; A. S. H.
„ 21	10 17	5 —4	49	46½	5	15 (about)	Ampthill - -	Bedford - -	209 — 9	κ *Virginid*	J. H. B.; A. S. H.
* „ 21	10 37	3	70	68	22	34	Dunstable - -	Olney, Bucks - -	218 — 31	θ *Centaurid*	J. H. B.; A. S. H.

* *See* page 25. † *See* page 26. ‡ *See* page 26.

REAL PATHS OF FIREBALLS AND SHOOTING STARS OBSERVED AT TWO OR MORE STATIONS IN 1899-1900—*continued.*

Date.	G.M.T.	Mag.	Height at Beginning.	Height at Ending.	Length of Obs. Path.	Velocity (per second).	Began over	Ended over	Radiant Point.	Name of Meteor.	Observers.
1900.	h m		Miles.	Miles.	Miles.	Miles.			α° δ°		
*May 3	13 58	5 —2	49—54	43—48	137—149	23—27	4 miles N.W.—1 mile N.E. Sevenoaks.	7 miles S.S.W.—12 miles S.W. by W. Cardiff.	335 − 2 (or 335±0)	γ *Aquarid*	J. H. B.; A. S. H.
*July 18	11 33	♃—♀	42	42	50	12½	Halstead, Essex -	13 miles E. by N. Orfordness, Suffolk.	209 − 8	κ *Virginid*	H. Campbell; G. M. Knight; A. S. H.
„ 18	11 44½	>1	92	69	41	35	3 miles N.W. Mildenhall.	3 miles S.W. Royston.	33 + 55	χ *Perseid*	J. C. W. H.; A. S. H.
„ 19	11 49	>1—♃	77	53	41	34	Basingstoke - -	7 miles E.S.E. Salisbury.	15 + 49	*Perseid*	W. F. D.; A. S. H.
„ 23	11 57	2	64½	45½	28½	57	9 miles E. by S. Clacton.	8 miles E.N.E. Shoeburyness.	27 + 54	ϕ *Perseid*	J. C. W. H.; W. E. B.
„ 23	12 12	2 —1	83	56	38	47½	Sevenoaks, Kent -	Horsham, Sussex -	20 + 51	*Perseid*	W. F. D.; A. S. H.
„ 24	11 26	1	65	56	20½	25½	3 miles N.W. Clare, Suffolk.	2 miles W. Newport, Essex.	32 + 40	γ *Andromedid.*	J. C. W. H.; W. E. B.
* „ 25	11 10	3 —1	73½	53½	34	48½	3 miles N.E. Brandon.	4 miles S.W. Sutton, Cambs.	8 + 38	π *Andromedid.*	W. F. D.; J. C. W. H.; A. S. H.
* „ 28	11 46	3 —1	62½	44½	53	29½	3 miles N.W. Whitchurch, Salop.	17 miles N. Abergele	339 − 11	δ *Aquarid*	W. F. D.; A. S. H.
* „ 28	12 35	4	82½	73	30½	38	5 miles E. by N. Swindon.	3 miles W. Stroud -	12½± 0 (or 16—4)	*Cetid*	W. F. D.; A. S. H.
„ 30	10 42	3 —1½	49	35½	18	30	Fakenham, Norfolk	N.E. of King's Lynn	354 + 49	λ *Honorid*, or *Andromedid.*	J. H. B.; J. C. W. H.
„ 30	12 0	4 —1	50½	43	18½	30½	4 miles W. Sudbury	1 mile W. Newmarket.	342 − 8	δ *Aquarid*	J. C. W. H.; A. S. H.
*Sept. 2	6 54	Fireball	85	18	86	20 (about)	2—3 miles W. Darlington.	2—3 miles E. Lancaster.	334 + 57	ζ *Cepheid*	23 observers.
*Oct. 23	12 29	3	94	80	14	43	N.N.W. of Clacton -	E. of Halstead -	99 + 13	γ *Geminid*	W. F. D.; A. S. H.
* „ 23	12 30	3 —2	90	58	46	25	S.S.E. of Slough -	Oxford - -	74 + 14	o *Orionid*	W. F. D.; A. S. H.
*Nov. 13	10 18	4 —1	71	59	19	27	Southampton -	Salisbury - -	58 + 7	*e Taurid*	W. F. D.; A. S. H.
* „ 13	13 32	2	72	61	24	48	Didcot - -	Swindon - -	150 + 22	*Leonid*	W. F. D.; A. S. H.
* „ 13	15 58	2½—1½	80½	61	23	46 (about)	N. of Ampthill -	Olney, Bucks - -	145 + 29	μ *Leonid*	J. C. W. H.; A. S. H.
„ 13	16 38	3	66	44	23	57½	W. of Leatherhead -	Esher, Surrey -	119 + 35	β (π) *Geminid*	J. C. W. H.; A. S. H.
„ 23	8 53	3½—2	90	74	24	30	S.W. of Grantham -	N.N.E. of Loughborough.	66 + 35	ϵ *Perseid* or ι *Aurigid.*	T. H. A.; A. S. H.

* *See* page 25. † *See* page 26. ‡ *See* page 26.

* Additional path calculations independent of those deduced for the same meteors by Mr. Denning.

1900, *January* 2, $6^h\ 41^m$.—The conditions of this early evening Quadrantid's motion were very unfavourable to its exact height determination, as the mapped arcs of flight at both the stations chased and overtook each other very nearly (though not quite as truly as they should have done) along the same great circle, and very precise descriptions of the apparent arcs' lengths and spacings on the circle can alone, in such conjunctions, afford thoroughly conclusive data for the meteor's real path determination. An impartial combination and discussion of the two recorded paths afforded, however, in this case, a result so entirely well consistent with the known scales in general of real heights and speeds of shooting stars, and here of the Quadrantid meteors, as to do much credit to the observers of this pair of meteor-tracks. A triflingly small change from $1\frac{1}{2}$ seconds to 1 second in Mr. Astbury's estimate of the meteor's flight-duration would also suffice to convert the calculated path-velocity from 25 miles to 30 miles per second, and this would agree quite closely with the theoretical speed of flight, 32 miles per second, of the Quadrantid meteors, supposing their stream to be moving in a parabolic orbit.

1900, *January* 27, $11^h\ 10^m$.—Although not sensibly different from Mr. Denning's path, this Canis Majorid's real path result is here included to show how perfectly the easily obtained determinations found by different computers of a meteor's real path agree together when the original apparent path descriptions are found to be in satisfactorily good geometrical accordance.

1900, *March* 28, $11^h\ 29^m$.—This meteor was a good example of a tribe of rather long and swift, slightly streaked or spark-tailed shooting-stars which diverged from centres in Hercules in pretty plentiful abundance during meteor-watches in March-April, 1900; and by its pair of mapped paths at Farnborough and Slough, its radiant-point was well fixed, near δ Herculis. The two tracks, 10° and 14° long, fitted each other, with courses favourably transverse to it, in perfect relation to the short base line of $15\frac{5}{8}$ miles between the stations, very well, requiring scarcely any adjustments in length to each other at the beginning and end points. But unless the base-line length ($15\frac{5}{8}$ miles) and direction (25° W. of S.) between Slough and Farnborough, used in this calculation (which were not determinable with much accuracy on different maps), were, perhaps, one or both of them very faulty, all the quantities in Mr. Denning's path-result seem really to be rather distinctly greater than what the observations would strictly furnish or allow us to gather satisfactorily in such good accordance with a simple theory of meteor velocities from their combination.

1900, *April* 20, $11^h\ 43^m$.—The three simultaneously mapped tracks of this γ Librid or Centaurid at Cambridge, Slough, and Farnborough, formed a close group of nearly parallel paths between 40° and 20° above the N.N.E. horizon, all proceeding from a distant backward common intersection-point very near the S. horizon at $214° - 30°$. This was very probably the meteor's real radiant-point, as several single paths and some doubly observed meteors were traced back to very near it on the Lyrid nights of 1900, April 20–21, and on a few later evenings. A less southern radiant, also on their path-lines, at $222° - 21°$, was used, however, for this real path construction as being about the middle point of a radiant-region of a marked abundance, in that April period, of long-pathed shooting-stars showing, indeed, no such distinct and well-marked centre there as that which seemed to be active and well-defined at about $215° - 30°$ nearer to θ Centauri and π Hydræ. The near agreement of the velocity, 27 miles per second, with the hyphothetically normal speed at which parabolic-pathed meteors would enter the earth's atmosphere from this path's adopted radiant-point, of 24 miles per second, leaves no room to doubt that a near approach to accuracy was reached, both in the observations themselves and in the conclusions which they have afforded of this γ Librid or Centaurid's real height, length of path, and speed of motion. Mr. Denning's independent calculation of the meteor's path with a different adopted radiant-point, S. of that here used and more nearly horizontal, satisfactorily corroborates these several path-features, and, moreover, clearly shows that the joint radiant-point of the three recorded path-lines at $214° - 30°$, might well be substituted alternatively, and, perhaps, more correctly, for the one used in the present real path's construction without otherwise introducing much change in its result or very materially altering its general conclusions.

1900, *April* 21, $10^h\ 4^m$.—A meteor triply observed at Farnborough, Wallingford, and Slough. While the apparent path at Slough, beginning 35° from the mean centre (at about $274° + 32°$ on the nights of 1900, April 20–21) of the Lyrid meteor system, about 15° in length, diverged directly from the radiant in Lyra, and with its backward horizon-point at $281° + 8°$, could have proceeded from neither of the two radiant centres, then also pretty active in Cerberus at about $272° + 21°$ and $283° + 23°$, the two closely neighbouring mapped paths at Farnborough and Wallingford, 10° or 12° long, crossed the Slough path-line backwards, from opposite sides, nearly at their own, and not far in the rear of the Slough path's, beginning points, at about $266° + 48°$, and led from these backwards to several degrees east and west from the usual Lyrid radiant centre. Although a centre of γ Draconids seemed to be feebly traceable on those two nights at about $269° + 43°$ (on this same meteor's path-line at Slough), had the three observed tracks proceeded from it, or from the neighbouring point $266° + 47°$ near their joint intersection, assigned as its radiant-point to the meteor's real path by Mr. Denning, they would, instead of being all long and rather swift flights, have presented, by the effect of perspective on the nearly end-on views of their courses, all so near that common radiant-point, very slow and exceedingly foreshortened courses. From its general direction, length of track, and swiftness at all the three stations, the meteor was evidently a true-centred Lyrid, and the congregation of directions of the three closely clustered tracks, close behind their starting points in the neighbourhood of γ Draconis, was quite clearly only an accident of the ordinary small liabilities to error of mapped meteor courses. Hence, for the meteor's real path construction, a radiant-point has been adopted, at $270° + 40°$, intermediate between the

latter intersection point, 266° + 48°, and the true Lyrid centre, 274° + 32°, not as a well determined one, but as denoting a possible deviation of the meteor's radiant-point position from that of the true Lyrids (perhaps to some extent borne out by the mapped path-directions at Farnborough and Wallingford) towards a sometimes noted offshoot meteor-focus, in about that quarter, from the Lyrid centre.

1900, *May* 3, 13h 58m.—Apparent path-lengths at Farnborough and Slough, 92° and 105°, in four seconds and six seconds, from 300° + 36° to about 179° + 34°, and from about 201° + 28° to 175° + 15°. As the end-point of this long γ Aquarid's path was seen rather imperfectly, and the direction of its flight, accordingly, at Farnborough was not very accurately mapped, as from 334° − 5° at the east horizon, and from a joint radiant or backward intersection (altitude about 14°) at 326° + 7° with the Slough path, whose horizon point in the east was 338° − 2°, a nearly horizontal flight of the meteor was assumed from a radiant point between these two paths at 335° − 2°, or 335° ± 0°. The heights, and the two whole path-lengths of 135–150 miles in the two path-calculations, do not differ from each other materially enough to afford any reasonable presumption that they could be much modified by a different mode of treatment of the observations, while they fully confirmed, in general, all the results of a previous determination, by Mr. Denning, of the meteor's real path. As six seconds was a well counted duration estimate of the full path at Slough, and as Mr. Bridger's note at Farnborough, of four seconds for the portion of it which he saw, would have to be raised to fully five seconds for the additional end-portion of the path which was there unseen, the least and greatest real speeds of flight which all the data and deductions furnished, ranged only, it appears, from 23 to about 27 miles. But for a parabolic, or nearly parabolic, meteor-stream moving in nearly the same orbit as Halley's comet, to which the date and radiant-point of the γ Aquarids of May 2–6 would nearly correspond, the theoretical velocity of these meteors' motions should be 40 miles per second, exceeding notably what this, we may pretty surely say, first well mapped pair of simultaneous observations of a γ Aquarid shooting-star seemed certainly to indicate.

1900, *July* 18, 11h 33m.—The whole course at Slough, of about 15° in four seconds, ending about 3° preceding α Trianguli, was directed back from η and κ Cassiopeiæ, and through points at 245° + 68° and 228° + 53°, from a horizon point in the W.S.W. at 207° − 13°. By combining it with Mr. Campbell's sketch map of the meteor's course among surrounding stars at Croydon, where its direction also passed backwards through Cassiopeia, Cepheus, and Draco, to the west horizon, one of the two former centres, of γ Ursæ Minorids and Quadrantids, might, it seemed possible, be thought to have produced the meteor, and it occurred to Mr. Denning that in his meteor watches of various previous years he had seen some extraordinarily slow meteors from the Quadrantid radiant-point about 230° + 51° in July and August. The whole aspect, however, of this meteor's long and low, leisurely descent much too plainly indicated a distant very long and level flight seen almost endwise, gradually approaching towards its anti-radiant point at or very near the E.N.E. horizon, to allow the substitution for that view of its true path direction of any radiant points at such high altitudes as those of the γ Ursæ Minorids and Quadrantids (the former at 61° and the latter at 53° of altitude in the N.N.W. and W.N.W.) to be regarded as anything more than a merely fanciful conjecture.

Although a real path on one of those assumptions was at first worked out by Mr. Denning, yet he also bravely endeavoured to reconcile together the Slough path and Mr. Campbell's rough star-sketch with a western horizon radiant-point at 214° − 10°, which a curvature in mid-path that the track seemed to show at Slough would certainly not make inadmissible, and out of the puzzling predicament as to this meteor's radiant-point a real path was thus obtained of by no means protracted length, 45 miles only, but owing to the adopted far-western radiant-point's extreme closeness, only 9° distant from it, to the anti-apex of the earth's way, yet exactly suited to explain, by the slow theoretical velocity of only 10¾ miles per second of parabolic-pathed meteors proceeding from this κ Virginis shower-centre, the long duration and great apparent sluggishness of motion of this very extraordinary looking meteor. For the real path assignment given in this Table, a κ Virginid radiant point only 5° removed from Mr. Denning's was taken on the Slough backward path-line, 4° in altitude above its west horizon point, and construing a little differently from Mr. Denning the names and significations of some of the guiding stars in Mr. Campbell's sketch, a lower height and slightly longer track were found than Mr. Denning's, but the two paths' vertical projections yet lie less than 10 miles apart, side by side, from one another across the southern part and coast of Suffolk.

1900, *July* 23, 12h 12m.—The foreshortened path of 6° at Bristol, and the long path of 24° at Slough, did not correspond in length correctly, having to be replaced by paths of 9° and 20° to fit the points of view from which they were recorded. The duration at Slough was uncertainly either 0·6 or 0·8 second, the latter being probably the nearer estimate for such a long-pathed Perseid, so that neither the real length of course nor its velocity could be well fixed, but the latter's measure, 47½ miles per second, did not actually exceed the parabolic-pathed meteor speed from this Perseid radiant-point, 39 miles per second, very greatly, and the general results of this path-comparison may thus, it appears, be finally considered to have been very fairly satisfactory. A third observation of the same meteor at Clapham, London, was furnished by Mr. Besley.

† An unsatisfactory and rather doubtful accordance, the path positions not agreeing very well, and leaving the radiant-point undetermined, and therefore here only conjecturally assigned. Radiants at 200° + 9° and 217° + 20°, which are on the Slough and Farnborough path-lines respectively were, perhaps, the real radiant sources of two independent meteors.

‡ The agreements in path-position were a little imperfect, but the quick, short path was certainly low in the atmosphere and the observed path-lines, nearly overlying each other, about 4° apart, led parallelly backwards to some low and distant south-eastern radiant-point. The adopted one near ξ Boötis appeared to be the most compatible with the path-descriptions, since an active radiant was suspected there by Mr. Bridger,

in this April period, at about 221° + 20°, and about eight or nine meteors seemed also to be distinctly noted from it by other observers on April 20–21. The two observed paths had a nearly common horizon-point, backwards, at 242° − 18°, near β Scorpii, for which the theoretical parabolic meteor-speed, 29 miles per second, would agree better than that of the adopted ξ Boötid radiant, 20½ miles per second, with the computed real speed, about 35 miles per second; but it seems rather more likely that the extremely short durations, ⅛th and ⅛th of a second, noted at Wallingford and Slough, were slightly under-rated, and that in consequence the meteor's real speed may quite possibly have agreed fairly well with that of a parabolic-moving stream from ξ Boötis.

The initials occurring in all the preceding tables refer to the observers as follows:—

E. M. A. = E. M. ANTONIADI, Paris.
T. H. A. = T. H. ASTBURY, Wallingford.
T. W. B. = T. W. BACKHOUSE, Sunderland.
W. E. B. = W. E. BESLEY, Clapham.
J. H. B. = J. H. BRIDGER, Farnborough.
C. L. B. = C. L. BROOK, Meltham.
W. F. D. = W. F. DENNING, Bristol.
A. S. H. = Prof. A. S. HERSCHEL, Slough.
J. C. W. H. = J. C. W. HERSCHEL, Cambridge.
A. K. = A. KING, Leicester (Ilfracombe in July).
W. H. M. = W. H. MILLIGAN, Belfast.

BRIGHT METEORS OBSERVED DURING 1900.

Date.	Time.	Mag.	Remarks.
1900.	h m s		
Jan. 2 -	14 58 0	3 × ♀	From 95° + 50° to 87° + 38°. Streak for about 10 secs. —Prof. A. S. HERSCHEL, Slough.
„ 2 -	16 17 0	♀	From 35° + 52° to 45° + 40°. Curved yellow streak for 6 secs.—Prof. A. S. HERSCHEL, Slough.
„ 9 -	2 55 0	VB	(*See* special account.)
„ 24 -	8 36 0	Sirius	From 177° + 35° to 184° + 30°. Duration 1½ secs.— T. H. ASTBURY, Wallingford.
„ 26 -	6 30 0 (Local Time)	1½ or 2 × ♀	From 75° − 12° to 135° − 7½°. Very swift. Very glowing red, with much paler edges.— Rev. E. G. ROBERTS, Masulipatam, India.
„ 26 -	10 0 0	>1	From 188° + 41½° to 191½° + 38°. Orange. Swift —A. KING, Leicester.
„ 27 -	11 10 0	>1	From 104½° + 31° to 108½° + 46½°. Yellow. Duration 1 sec. In last 5° of path appeared as a streak. —A. KING, Leicester.
Mar. 28 -	8 32 0	Several × ♀	(*See* special account.)
„ 28 -	9 21 0	>1	From 89° + 7¾° to 87° + 4½°. Orange. Swift.—A. KING, Leicester.
„ 28 -	11 8 0	Sirius	From 160° + 14° to 159° + 13°. Yellowish white. Duration 0·4 sec.—Prof. A. S. HERSCHEL, Slough.
Apr. 1 -	7 10 0	>♀	Passed above the moon and below Venus towards the N.W.—L. H. JOHNSON, Lewisham.
„ 2 -	10 24 0	1 or >1	From 159½° + 19° to 152° + 20½°. White. Moderately swift.—A. KING, Leicester.
„ 5 -	8 31 45	♀	From 175° + 3° to 175° − 15°. Intensely green colour, tinted with red. Duration 5 secs. Momentary train.—Rev. S. J. JOHNSON, Bridport.
„ 17 -	8 45 0	1 or Capella	From 175° + 64° to 177° + 67°. Yellowish white. Duration 0·3 or 0·4 sec.—Prof. A. S. HERSCHEL, Slough.
„ 18 -	10 47 0	♂	At 161° − 31°. Orange-yellow. Duration ½ sec.—Prof. A. S. HERSCHEL, Slough.

Date.	Time.	Mag.	Remarks.
1900.	h m s		
Apr. 19 -	9 5 0	4	From 38½° + 43° to 39½° + 40°. Swift.—A. KING, Syston, near Leicester.
„ 19 -	9 58 0	Sirius	From 246° + 34½° to 235¾° + 31½. White. Rather swift. Streak.—A. KING, Syston, near Leicester.
„ 19 -	10 54 0	> 1	From 226½° + 33½° to 231° + 27°. White. Duration 1½ to 2 secs.—A. KING, Syston, near Leicester.
„ 20 -	9 20 0 (about) (Local Time)	2 × ♀	From about 232½° + 10° to about 200° − 20°. White. Duration about 4½ secs. Train. — Rev. E. G. ROBERTS, near Masulipatam, India.
„ 20 -	9 43 0	4	From 220° + 18° to 205° + 9°. White. Duration 1·1 secs. Streak.—J. H. BRIDGER, Farnborough.
„ 20 -	10 20 0	> 1	From 285½° + 30½° to 286° + 27°. White. Slow.—A. KING, Syston, near Leicester.
„ 20 -	11 42 30	Vega	From 320° + 59° to 340° + 58°. Yellow. Duration 0·6 sec.—Prof. A. S. HERSCHEL, Slough.
„ 20 -	11 53 0	Arcturus	From 218° + 29° to 212° + 19°. Yellowish-white. Duration 0·4 or 0·5 sec.—Prof. A. S. HERSCHEL, Slough.
„ 20 -	12 20 0	Sirius	From 12° + 63½° to 22° + 61½°. Yellow. Swift.—A. KING, Syston, near Leicester.
„ 20 -	13 43 0	Vega	From 181° + 39½° to 165½° + 33°. Duration 0·5 or 0·6 sec.—Prof. A. S. HERSCHEL, Slough.
„ 21 -	9 55 0	> 1	From 304° − 67½° to 302½ + 65½°. White. Swift.—A. KING, Syston, near Leicester.
„ 21 -	11 11 0	Sirius or 4	From 311° + 43° to 312° + 41°. Yellow. Duration. 0·4 sec.—Prof. A. S. HERSCHEL, Slough.
„ 21 -	14 6 30	Vega	From 190° + 16½° to 174° ± 0°. White, then bright golden yellow. Duration 0·6 sec. — Prof. A. S. HERSCHEL, Slough.
„ 28 -	11 10 0	Sirius	From 218° + 51° to 172° + 70°. Blue. Duration a little over 2 secs —A. KING, Leicester.
May 3 -	14 38 30	δ or Sirius	From 270° + 69° to 181° + 43°. Orange-yellow. Duration 4 or 4½ secs. Streak or spark tail for about 1 sec.—Prof. A. S. HERSCHEL, Slough.
„ 4 -	14 3 30	Vega	From 232° + 62° to 222° + 75°. Bright yellowish-white. Duration, 0·6 sec.—Prof. A. S. HERSCHEL, Slough.
„ 5 -	8 20 0	Several × ♀	(*See* special account.)
„ 7 -	13 57 30	Arcturus	From 286° + 82° to 303° + 78°. Bright orange. Duration, 0·7 sec.—Prof. A. S. HERSCHEL, Slough.
„ 24 -	11 13 0	>1	From 255½°+56½° to 259°+52½°. Blue. Swift.—A. KING, Leicester.
June 10 -	9 10 0	1½ × ♀	(*See* special account.)
„ 24 -	10 57 30	> ♀	From 213° + 44½° to 203° + 22°. Yellow. Duration 2½ secs. Short train.—A. KING, Leicester.
July 15 -	10 12 0	> 1	From 83°+ 53½° to 97° + 43°. Duration 3½ secs.—W. F. DENNING, Bristol.
„ 15 -	10 12 0	♀	From 213°+28° to 186°+29°. White. Duration 10 secs. Bulbous in form. Head of bulb a beautiful green. Major axis 10′; minor axis 5′. Began to break up at end of journey, and burst after expanding. Slight streak.—H. J. TOWNSHEND, Leeds.
„ 15 -	10 14 0	2 × ♀	From 230°+35° to 148°+37°. Yellowish-white. Duration 4 secs. Reddish-orange colouration behind the nucleus for about 1°. Head divided into two parts during last quarter of path, perhaps as bright as Arcturus and Sirius respectively.—C. L. BROOK, Meltham, Huddersfield.

Date.	Time.	Mag.	Remarks.
1900.	h m s		
July 17 -	8 47 0	VB	(*See* special account.)
„ 18 -	11 31 30	Rather < ♃, nearly = ♀	From 18½° + 43° to 23½° + 29°. Greenish-white, then yellowish, with very red excrescence behind. Duration about 4·0 secs.—Prof. A. S. HERSCHEL, Slough.
„ 18 -	11 45 0	1 or > 1	From 11° + 66° to 347° + 71°. Greenish or yellowish-white. Duration 1·0 or 1·2 secs. Streak for 2½ secs. —Prof. A. S. HERSCHEL, Slough.
„ 19 -	11 48 0	♃	From 344° + 33° to 329° + 19°. Duration 1·1 secs. Streak.—W. F. DENNING, Bristol.
„ 19 -	11 49 0	= or > Vega	From 273° + 36½° to 258° + 20°. White. Duration 1·2 secs. Streak for 2 or 3 secs.—Prof. A. S. HERSCHEL, Slough.
„ 20 -	11 39 0	Sirius	From about 127°+67° to 135°+59°. White. Duration ¾ sec.—Prof. A. S. HERSCHEL, Slough.
„ 23 -	10 43 0	Arcturus	From about 135°+30° to about 192° + 48°. Reddish. Miss E. LANGDON, Clapham.
„ 23 -	12 13 30	♀	From 303½° + 38½° to 280° + 16°. Duration 0·4 sec Streak.—W. E. BESLEY, Clapham.
„ 23 -	12 15 30	> 1	From 350° + 42½° to 332½° + 47½°. Duration 0·3 sec. Streak.—W. E. BESLEY, Clapham.
„ 23 -	12 57 0	> 1	From 357°+7° to 9°+19°. Duration 0·4 sec.—W. E. BESLEY, Clapham.
„ 23 -	13 1 30	♃	From 322°+9½° to 288°+1½°. Duration 0·3 sec. Streak. —W. E. BESLEY, Clapham.
„ 23 -	13 16 30	> 1	From 323°+8° to 310°−10°. Duration 0·3 sec. Streak. —W. E. BESLEY, Clapham.
„ 24 -	10 50 30	> 1	From 305° + 30½° to 315° + 19½°. Duration 0·3 sec. —W. E. BESLEY, Clapham.
„ 24 -	10 49 0	VB	(*See* special account.)
„ 24 -	13 2 0	> 1	From 333° + 18½° to 313° + 6½°. Duration 0·4 sec. Streak.—W. E. BESLEY, Clapham.
„ 24 -	13 25 30	♃	From 3°+22° to 351°+11°. Duration 0·3 sec. Streak. —W. E. BESLEY, Clapham.
„ 24 -	14 4 0	♀	From 310°−12½° to 319°−13°. Duration 0·5 sec.—W. E. BESLEY, Clapham.
„ 28 -	12 25 0	♃	From 334° − 7° to 340° − 16°. White. Swift.—W. F. DENNING, Bristol.
„ 30 -	9 30 0	♃	From 29°+59° to 24½°+36°. Bluish-white, then yellow with small red sparks. Duration 2·5 or 2·7 secs.— Prof. A. S. HERSCHEL, Windsor.
„ 30 -	14 19 0	> 1	From 6° + 23½ to 1° + 13°. Swift. Streak.—W. F. DENNING, Bristol.
„ 31 -	10 37 0	Arcturus	From 3° S. Ras Alague passed close to β and disappeared close to α Capricorni. Pale orange. Duration about 2 secs.—H. A. BRIGHT, Hornsey.
„ 31 -	10 51 0	♃	From 345° + 30° to 332° + 13½°. Duration 1·0 sec. Streak.—J. H. BRIDGER, Farnborough.
„ 31 -	10 52 0	♀	From 320°+22½° to 305°+7½°. Duration 0·6 sec. Streak for 1·5 secs.—W. E. BESLEY, Clapham.
„ 31 -	10 52 0	> ♃	From 2° S. Deneb passed through Delphinus to 3° S. β Aquilæ. Deep orange. Swift. Streak for some seconds.—H. A. BRIGHT, Hornsey.

Date.	Time.	Mag.	Remarks.
1900.	h m s		
Aug 1 -	11 53 0	Sirius	From 219° + 4⅛° to 211° + 45°. White. Duration 0·6 sec. Double. Streak for 2 secs.—Prof. A. S. HERSCHEL, Slough.
„ 4 -	10 36 0	>1	From 293⅜° + 72½° to 283⅓° + 39°. Whitish. Duration about 2½ secs. Train. Streak.—A. KING, Leicester.
„ 4 -	11 43 0	>1	From 332½° + 54½° to 313° + 72°. Blue. Rather swift, then of moderate velocity.—A. KING, Leicester.
„ 9 -	10 40 0	♀	Fell vertically a little to the E. of the moon.—H. J. TOWNSHEND, Patterdale, Cumberland.
„ 11 -	10 41 30	Nearly = Vega.	From 330° + 65° to 297° + 49°. Bright white. Duration 1·1 secs. Streak for 1 sec.—Prof. A. S. HERSCHEL, Slough.
„ 11 -	10 49 0	Nearly = Sirius.	From 250° + 82° to 245° + 60°. Bright white. Duration 1·1 or 1·2 secs. Streak for 1 sec.—Prof. A. S. HERSCHEL, Slough.
„ 11 -	12 8 0	Vega	From about 270° + 28° to 263° + 13°. Yellowish-white. Duration 0·6 or 0·7 sec.—Prof. A. HERSCHEL, Slough.
„ 12 -	9 27 0	♀	Disappeared about 149° + 47°.—T. W. BACKHOUSE, West Hartlepool.
„ 12 -	10 21 0	>♀	From 211½° + 30° to 271° − 7°. Bluish white. Swift. Streak for 4 or 5 secs.—Rev. T. E. R. PHILLIPS, Yeovil.
„ 12 -	10 23 0	Nearly = 2	From 252° + 24° to 195° + 59°. Orange. Duration 4 or 5 secs. Slow. Short train.—Rev. T. E. R. PHILLIPS, Yeovil.
„ 12 -	11 5 30	>1	From 105° + 78° to 130° + 78°. Blue. Swift. Streak.—A. KING, Leicester.
„ 12 -	11 7 0	>1	From 47° + 69½° to 40½° + 70°. Dull green. Moderate velocity. Head. Train. Streak.—A. KING, Leicester.
„ 12 -	11 44 0	>1	From 343° + 70½° to 297° + 62°. Rather swift. Head. Streak.—A. KING, Leicester.
„ 12 -	12 28 30	>1	From 10° + 56° to 16° + 53°. Greenish. Slowish. Head. Streak.—A. KING, Leicester.
„ 12 -	12 42 0	Vega	From 343° + 67° to 333° + 44°. White. Duration 0·8 sec.—Prof. A. S. HERSCHEL, Slough.
„ 12 -	12 48 30	Nearly = Sirius.	From 80° + 83° to 130° + 86°. Yellow. Duration 0·6 sec.—Prof. A. S. HERSCHEL, Slough.
„ 12 -	12 49 0	2	From 56½° + 68⅔° to 60½° + 73½°. Blue. Swift. Streak.—A. KING, Leicester.
„ 12 -	14 0 0 (shortly after).	VB	Appeared immediately above Gemini. Direction almost vertical. Pear-shaped. Short tail.—H. C. CHRISTIAN, Wimbledon.
„ 13 -	9 15 0	3 × 2	Passed exactly over β Libræ to about 228° − 20°. Green. Duration 1½ secs. Streak for a few seconds.—C. L. BROOK, Slaidburn.
„ 13 -	10 31 0	Vega	From about 277° + 47° to 239° + 64½°. Bluish-white Duration about 1·5 secs.—J. H. BRIDGER, Farnborough.
„ 13 -	11 27 0	Vega	From 293° + 55° to 280° + 36°. Bright white. Duration 0·7 sec. Streak for 1 sec.—Prof. A. S. HERSCHEL, Slough.
„ 13 -	11 27 0	>1	From 44½° + 74° to 47½° + 69½°. Pale yellow. Rather swift.—A. KING, Leicester.

Date.	Time.	Mag.	Remarks.
1900.	h m s		
Aug. 13 -	14 19 0	4	From about 107° + 55° to about 36° − 5°. White Duration 11 secs. Fine tapering tail or "trail."—J. C. W. HERSCHEL, Cambridge.
„ 15 -	10 30 0	>♀	From midway between α and δ Ursæ Minoris to about 107° + 57°. Pale blue.—T. W. BACKHOUSE, Dryderdale, near Wolsingham.
„ 18 -	12 25 0	Nearly = 4	From 357° + 15° to 3½° + 22°. Very slow. Train.—W. F. DENNING, Bristol.
„ 19 -	10 36 0	VB	Disappeared at 198° + 26°. Slow. Gave several flashes.—W. F. DENNING, Bristol.
„ 19 -	10 36 30	3 × ♀	From 191° + 37° to 182½° + 27°. White, with a tinge of blue. Slow.—Rev. T. E. R. PHILLIPS, Yeovil.
„ 20 -	10 1 0	>♀	Disappeared at 1° − 10°. Brilliant flash seen through a cloud.—W. F. DENNING, Bristol.
„ 22 -	10 7 30	4	From 335° + 46° to 343¾° + 41½°. Yellow. Slow. Head. Streak.—A. KING, Leicester.
„ 27 -	9 9 0	Arcturus	From 260° + 44° to 267° + 11°. Swift.—S. BOLTON, Leeds.
„ 30 -	9 40 0	>1	From 307° + 37½° to 308° + 12¾°, Duration 0·4 sec.—W. E. BESLEY, Midsomer Norton, near Bath.
Sept. 1 -	10 53 0	4	From 346° + 48¾° to 330° + 41°. Rapid. Streak.—W. F. DENNING, Bristol.
„ 1 -	13 40 0	4	From 49° + 56° to 3° + 51°. Rapid. Streak.—W. F. DENNING, Bristol.
„ 2 -	6 54 0	VB	(*See* special account.)
„ 9 -	9 8 0	♀	Dropped almost vertically 20°, or slightly more, E. of moon. Steely-blue. Moderate velocity.—A. KING, Leicester.
„ 12 -	10 11 0	4	From altitude of 10° far below ζ Pegasi to altitude about 5° far below γ Pegasi.—Rev. S. J. JOHNSON, Bridport.
„ 16 -	8 44 0	♀	From 193° + 39° to 181¼° + 38°. Slow.—W. E. BESLEY, Clapham.
„ 16 -	8 45 0	> 4	From the neighbourhood of κ Persei to about 10° or 15° above the horizon, with inclined path. Colour of Aldebaran.—T. HARRIES, Llanelly.
„ 23 -	7 44 0	>1	From 326° + 57½° to 337° + 39°. Swift, Streak.—W. F. DENNING, Bristol.
„ 24 -	9 1 0	> Arcturus.	From 259° + 45° to 263° + 22°. Rather swift. Streak for 1 sec.—S. BOLTON, Leeds.
„ 25 -	11 0 0	>♀	Disappeared at 257° + 37°. Length about 5° directed from β Lyræ. Bluish-white.—W. E. BESLEY, Clapham.
„ 30 -	9 51 0	VB	Brilliant meteoric flash, perhaps N. of Fomalhaut (behind the observer). Swift.—W. F. DENNING, Bristol.
Oct. 2 -	10 2 0	♀	From a point overhead travelled from N. to S.S.E. and disappeared about midway between zenith and horizon. Remarkably slow.—W. H. IZZARD, Brentford.
„ 17 -	11 43 30	Nearly = Sirius.	From 269⅜° + 72° to 270° + 56°. Bright white. Duration 1·1 to 1·2 secs. Streak for 2 secs.—Prof. A. S. HERSCHEL, Slough.

Date.	Time.	Mag.	Remarks.
1900.	h m s		
Oct. 21 -	8 35 30	VB	(*See* special account.)
„ 21 -	8 44 0	VB	(*See* special account.)
„ 21 -	9 25 0	VB	(*See* special account.)
„ 21 -	10 0 0	>1	Travelled towards N.W. horizon from about altitude 60° to about altitude 30°. Bluish-white. Duration more than 1 sec. Tail.—C. A. BESLEY and W. H. CORBOULD, Jun., Clapham Common.
„ 21 -	11 40 0	Sirius or 4	From 19° + 22° to 352° + 9°. Bright white. Duration 1·0 or 1·2 secs. Streak for 4 secs.—Prof. A. S. HERSCHEL, Slough.
„ 21 -	11 58 0	♀	From 149° + 46° to 155° + 38°. Yellow, then orange-red. Duration 1·2 secs.—Prof. A. S. HERSCHEL, Slough.
„ 21 -	11 59 0	= Betelgeuze.	From 103½° + 13½° to 113° + 13°. Duration about 1½ secs. Green and orange streak.—C. L. BROOK, Meltham, Huddersfield.
„ 23 -	12 21 30	>Sirius, nearly = 4	From 80° + 25° to 98° + 30°. Bluish white. Duration 1·4 or 1·5 secs. Orange yellow spark tail for 1½ or 2 secs.—Prof. A. S. HERSCHEL, Slough.
„ 27 -	9 35 30	>Vega	From 133° + 47° to 126° + 41°. Pure white. Duration 4·0 secs.—Prof. A. S. HERSCHEL, Slough.
„ 27 -	11 42 0	>♀	From 79° + 33° to 56° + 24¾°. Left a bright, irregular streak, which drifted thus (brighter portion): 11h 42m, 66½° + 29¾°; 11h 45m, 68° + 25½°; 11h 47m, 69° + 22¾° (one fragment like a sickle); 11h 50½m, 71° + 17¾°; 11h 55m, 72° + 12¼°.—W. F. DENNING, Bristol.
„ 28 -	9 20 0	VB	In the Eastern sky. Travelled from N. to S. with a downward trend. Bluish. Faint trail.—C. H. FRY, Clevedon.
„ 29 -	6 33 0	VB	From about 240° + 70° to about 255° + 38°. Steady motion. Train.—Miss E. LANGDON, Clapham.
Nov. 1 -	7 0 0	VB	Travelled from S.E. to N.W. Duration 10 seconds. Very long tail.—T. PINK, Castletownroche, Cork.
„ 3 -	16 51 0	= or >4	From 130½° + 50° to 164° + 42½°. Slowish. Bright white train.—W. F. DENNING, Bristol.
„ 10 -	12 45 0	♂	From 277° + 57° to 269° + 52°. Orange-yellow. Duration 0·7 sec.—Prof. A. S. HERSCHEL, Slough.
„ 13 -	6 14 30	Sirius	From 308° + 21° to 267° + 4°. Duration 4 or 5 secs. Streak.—C. L. BROOK, Meltham, Huddersfield.
„ 13 -	8 34 0	Sirius, then 1-2.	From 53° + 44° to 50° + 58°. Pure white, orange, red. Duration 1·1 or 1·2 secs. Taurid.—Prof. A. S. HERSCHEL, Slough.
„ 13 -	11 40 0	>♀	From 10° + 51½° to 318° + 54°. Slowish. Train. Taurid.—W. F. DENNING, Bristol.
„ 13 -	15 47 0	Sirius	From 97°—1½° to 114°—9°. Quick.—C. L. BROOK, Meltham, Huddersfield.
„ 13 -	15 48 0	♀	From 10° + 50° to 350° + 53°. Orange red, with greenish-white flashes. Duration 2¼ secs. Taurid. —Prof. A. S. HERSCHEL, Slough.
„ 14 -	11 26 0	>4	From 2° + 26° to 355° + 20°. Not very swift.—W. E. BESLEY, Clapham.
„ 24 -	12 45 0	>4	From 31° + 62° to 290° + 64°. Yellow. Slow. Train. W. F. DENNING, Bristol.
„ 16 -	10 55 0	VB	From S.E. to S.W., inclined at an angle of 30°. Moderate velocity.—G. E. GUTTERIDGE, Westminster.

Date.	Time.	Mag.	Remarks.
1900.	h m s		
Nov. 16 -	10 58 0	♀	From 5° + 22° to 0° + 6°. Orange, with white flashes. Duration 2½ secs.—Prof. A. S. HERSCHEL, Slough.
„ 17 -	12 0 0 (just after).	VB	Travelled in a northerly direction. Train similar to a rainbow, extending some distance, and expanding like a rocket.—Observer at Cricklade.
„ 25 -	8 8 30	Nearly = Sirius.	From 119° + 61° to 134° + 53°. Bright white, then orange-yellow. Duration 2·1 or 2·2 secs.—Prof. A. S. HERSCHEL, Slough.
„ 27 -	9 5 0	> 1	From 65 — 9° to 75° — 11½°. Yellowish. Duration 2·0 secs.—J. H. BRIDGER, Farnborough.
„ 27 -	11 9 30	Vega	From 338° + 12° to 328° + 2°. Pale bluish or greenish-white. Duration 2·1 secs. Andromedid.—Prof. A. S. HERSCHEL, Slough.
Dec. 10 -	5 37 0	Aldebaran.	From zenith to below γ Arietis. Colour of Aldebaran. Double, each part being as bright as that star.—S. H. R. SALMON, South Croydon.
„ 11 -	10 43 30	> 1	From 78° + 6° to 71° + 5°. Pale orange. Moderate velocity. Very small head.—A. KING, Leicester.
„ 12 -	8 18 0	Sirius	From 130° + 41½° to 151° + 45°. Greenish. Duration, 1½ secs.—C. L. BROOK, Meltham, Huddersfield.
„ 13 -	10 18 0	> 1	From 88½° + 8° to 82½° + 3°. Blue. Slowish. Small head. Train.—A. KING, Leicester.
„ 13 -	10 19 0	> 1	From 119° + 45° to 125° + 53°. Rapid. Streak.—T. H. ASTBURY, Wallingford.
„ 13 -	10 53 0	> 1	Very short course near 65 and 63 Aurigæ. Lilac. Geminid.—A. KING, Leicester.
„ 13 -	11 43 30	Sirius	From 148° + 41½° to 143¾° + 40¼°. Yellow. Swift. Head. Streak.—A. KING, Leicester.
Dec. 13 -	11 58 0	2 × ♀	From 57° + 31½° to 27° + 19¾°. Yellowish-white. Duration 1·3 or 1·5 secs. Streak for 2 secs.—Prof. A. S. HERSCHEL, Slough.
„ 13 -	12 26 0	Sirius or ♃	From 82° + 11° to 50° + 16°. Yellow. Duration 1·5 secs. Streak for 1 sec.—Prof. A. S. HERSCHEL, Slough.
„ 15 -	12 0 0	> 1	From 78¾° + 35° to 80½° + 31¾°. Rather swift. Small head.—A. KING, Leicester.
„ 21 -	11 54 30	Vega	From 84½° — 22° to 80° — 25½°. Yellow. Duration 1·0 sec.—Prof. A. S. HERSCHEL, Slough.
„ 21 -	12 7 0	Capella	From 55° + 70° to 45° + 76°. Orange-yellow. Duration 0·4 sec.—Prof. A. S. HERSCHEL, Slough.
„ 28 -	7 27 0	♃	Directed from γ Orionis (nearly) to about 50°—9°. Blue. Moderate velocity.—J. H. BRIDGER, Farnborough.

"VB" in column 3 signifies "Very Bright."

WALTER E. BESLEY,
Director.

Clapham,
1901, January 31.

Photograph of Theophilus and the surrounding region, taken by Mr. G. W. Ritchey, with the 40-in. refractor of the Yerkes Observatory, 1900, October 12.

(Reproduced by permission of Professor G. E. Hale, Director of the Yerkes Observatory.)

SECTION FOR THE OBSERVATION

OF

THE MOON.

DIRECTOR.—WALTER GOODACRE, F.R.A.S.

FIFTH REPORT OF THE SECTION.

Introduction.

During the interval that has elapsed since the publication of the Fourth Report of the Section, a good deal of steady and useful work has been accomplished by the Members. Of this work some particulars will be found in the following pages.

In 1897, September, the Director issued a circular giving a list of formations for regular observation, and the results of the efforts of the Members in connection with the same have been published in the last reports. Some further results are recorded in this report; at the same time there is still much to be done in each case before our knowledge of the form and detail shown by these lunar formations can be regarded as approximately complete.

The detection and recording of their coarser features is an easy task, but as the finer details are sought for the difficulties increase in an accelerating ratio.

To produce good work of this nature requires great care and persistence.

The opportunities, when definition is of the best, and the object in view favourably situated, are so seldom found in combination, that rapid progress in the charting of the lunar surface is quite out of the question.

It may serve a useful purpose to mention that since the publication of the last report the following papers have appeared in the "Journal" dealing with lunar matters :—

Vol. IX.—Report of the total eclipse, 1898, December 27.
" On the relative chronology of the lunar formations.
Vol. X.—Tables for determining the position of the terminator from 1900 to 1999.
" Report of the partial eclipse, 1899, December 16–17.
" The light streaks on Ptolemæus.
Vol. XI.—On mapping the surface of the moon.

In connection with the last-mentioned paper (by Mr. Saunder), the Director has the pleasure to report that the four skeleton

maps drawn by Mr. B. E. Cammell have been reproduced and issued to Members of the Section, as well as to several other English and Foreign observers.

It is too early yet to be able to announce results, but some work has been accomplished. It requires only a little persistence and enthusiasm on the part of the Members of the Section to so complete these maps that the Association may justly claim to have produced charts of this portion of the lunar surface, unapproachable in their accuracy.

The Section is again much indebted to Mr. S. A. Saunder for a further instalment of his micrometrical measures of position on lunar photographs which appears in the report, as well as for his further and valuable report on Ptolemæus.

It requires but a superficial knowledge to enable one to appreciate the value of such original work as Mr. Saunder is carrying on, simplifying, as it does to a large extent, the difficulties which have hitherto barred the way to any adequate progress being made in the task of accurately delineating the details of the lunar surface.

The thanks of the Director are due to those Members who have sent him from time to time valuable and interesting notes and sketches, some of which are reproduced in the following pages.

This report would be in no sense complete without some brief reference to the work of contemporary selenographers.

In the region of lunar photography, although a further issue of plates by the Paris Observatory is announced, selenographers are still without a complete lunar photographic atlas; one, however, is promised very shortly by Prof. W. H. Pickering. Herr Krieger's first volume of lunar drawings based on photographs has not yet been succeeded by a second. Dr. Weinek has, however, issued recently a further volume of observations made at the Prague Observatory between the years 1892–1899, which volume, as might have been anticipated, is largely occupied with details of lunar objects depicted in Dr. Weinek's well-known masterly fashion. This volume, therefore, is of the greatest interest to all engaged in lunar work. Among the choice drawings based on photographs which adorn this volume may be mentioned those representing Vandelinus, Langrenus, and Copernicus.

Prof. W. H. Pickering, of Harvard, is still giving much attention to various lunar problems; some of the interesting and valuable results he has obtained in recent years are to be found in Vol. 32, Parts 1 and 2, of the "Annals of the Harvard College Observatory."

It would be quite impossible to do justice to these papers of Prof. W. H. Pickering in the few lines at our disposal in this report, reference must, therefore, be made to the above-mentioned volume by those who wish to see what the Professor has been able to do, and such a reference will amply repay the time spent.

Papers will be found on Plato, Linné, Schrœter's Valley, Messier, and Messier A.*

* Some further reference to these last three papers appears under their respective headings in this report.

In order to further illustrate the scope of Prof. W. H. Pickering's activity, mention should be made of his other papers on "Lunar Atmosphere," "Minor Details," "Bright Streaks," "The Evidences of the Action of Water on the Lunar Surface," "A Calalogue of River Beds," variable spots on Hansteen, Atlas, and Alphonsus.

In Vol. XIV. of the "Bulletin de la Société Astronomique de France" is a most interesting communication by M. Charbonneaux, Assistant Observer at Meudon, in which he describes an anomalous appearance in a small crater just east of Theætetus, and which led him to the conclusion that this craterlet was the source of an active volcanic outbreak. The craterlet was seen from time to time obscured for short intervals by a whitish cloud, and from this he would assume also the existence of a lunar atmosphere of some sort. M. C. M. Gaudibert (whose recent death robs France of her greatest selenographer,) wrote in a subsequent number that he had examined this object very carefully, and failed to find anything anomalous in its appearance, but admits that the conditions at the time were not favourable for observing so small an object. Thus the matter is left for the present.

List of Members of the Section.

ATTKINS, E., Archway Road, Highgate. 6½-in. Spec.
BRIDGER, J. H., Mus. Bac., Farnborough. 4-in. O.G.
BROOK, C. L., M.A., F.R.A.S., Meltham, Huddersfield. 9½-in Spec.
BOLTON, Scriven, Leeds. 4⅛-in. O.G.
BROWN, G. L., Stirling. 10½-in. Spec.
CARR, The Rev. Canon, F.R.M.S., Holbrooke Hall, near Derby. 4½-in. O.G.
CARLAW, Thos., Lanark. 10¼-in. Spec.
CORDER, Hy., Bridgwater. 6½-in. Spec.
DANKSEN, Jno., F.R.A.S., Glasgow. 13-in. Spec.; 6-in. O.G.
ELLIS, Hy., F.R.A.S., Potters Bar. 6-in. O.G.
FOULKES, Rev. T. H., M.A., Malta.
GOODACRE, Walter, F.R.A.S., 1, Birchington Road, Crouch End, N., *Director*. 12-in. Spec.
GREENWOOD, J. A., B.A., LL.M., F.R.A.S., Funtington House, near Chichester. 5¼-in. O.G.
HALL, W. J., Nantwich. 4½-in. Spec.
HALLOWES, G. P. B., F.R.A.S., York.
HODGE, R., Stroud Green, N. 8½-in. Spec.
HUNTER, David, F.R.A.S., Lanark. 10¼-in. Spec.
HUTCHINGS, Rev. R. S., F.R.A.S., Salisbury. 12¼-in. Spec.
MACKAY, Rev. A., M.A., Halkirk, N.B. 7-in. O.G.
MAW, W. H., F.R.A.S., 18, Addison Road, W., and Outwood, Surrey. 6 in. O.G.; 8-in. O.G.
MEE, A. P. B., F.R.A.S., Cardiff. 8½-in. Spec.
MERLIN, A. A. C. E., Volo, Greece.
MEERS, A. W., F.R.G.S., Beckenham. 6½-in. O.G.
MOLESWORTH, P. B., Capt.R.E., F.R.A.S., Trincomalee, 12¼-in. Spec.

MOYE, M., D. en D., Montpelier, France.
ORR, Miss M. A., Frimley, Surrey.
OFFORD, J. Milton, F.R.M.S., Ealing, W. 12¼-in. Spec.
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R. J. RYLE, M.A., M.D., F.R.A.S., Brighton.
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SMART, D., M.R.C.S., L.R.C.P., F.R.A.S., 108, Grange Road, S.E. 10-in. Spec.
SMITH, C. F., Edinburgh. 5¼-in. Spec.
SOLA, J. Comas, Barcelona. 6-in. O.G.
SMITH, T. J. F., Wavertree. 3½-in. O.G.
STRAKER, Donald, Oakleigh Park, N. 9½-in. Spec.
STUTTER, Rev. E. J. (O.S.B.), F.R.A.S., Acton Burnell, Shrewsbury. 4½-in. O.G.
TOMKINS, H. G., Allahabad. 9-in. Spec.
WADSWORTH, Rev. H., F.R.M.S., Coalville East. 8½-in. Spec.
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WHICHELLO, Dr. H., Tattenhall, Chester. 9-in. Spec.; 6-in. O.G.

Our Frontispiece.

The Association is under great obligation to Prof. G. E. Hale, D.Sc., F.R.A.S., Director of the Yerkes Observatory, for his ready kindness and courtesy in granting permission for the reproduction in this Report (*see* Plate I.) of the beautiful lunar photograph taken by Mr. G. W. Ritchey.

Those of our Members who have seen and examined the glass positive of the photograph, presented by the Yerkes Observatory to the Royal Astronomical Society, will readily concur in the opinion that nothing finer in the way of lunar portraiture has yet been secured, and will join heartily in congratulating Mr. Ritchey on his magnificent success, and in expressing the hope that this is but the precursor of many such beautiful lunar pictures.

A full description of the methods adopted by Mr. Ritchey in securing celestial photographs is to be found in the "Astrophysical Journal," 1900, December, a perusal of which will interest everyone, even those not conversant with the technicalities of the photographic method.

The most notable feature in Mr. Ritchey's method is that he was able to use the *full* aperture of the 40-in. refractor.

The plates were also exposed at the *visual* focus, the necessary correction being obtained by the interposition "of colour screens "made of thin plane-parallel plates of glass coated with collodion "of a delicate greenish-yellow tint, which, when tested with "the spectroscope, were found to effectually shut out the blue "end of the spectrum while transmitting the yellow, green, and "red, without appreciable diminution of intensity. . . . . "A special plate-holder was constructed, the colour-screen being "mounted in the plate-holder in contact with the sensitive plate. "Cramer's instantaneous isochromatic plates were used, these "being extremely sensitive to yellow light, while their sensi-

" tiveness falls off rapidly in the orange and red on the one " side and the green on the other, increasing again in the blue. " . . . . The photograph of the lunar crater *Theophilus* " and surrounding region is from a negative obtained with the " 40-in. telescope, October 12th, 1900. The enlargement, as " compared with the original negative, is about six diameters. " The full aperture of the telescope was used, and the exposure " time less than half a second."

Aristarchus and Herodotus.

These interesting objects, together with the Great Winding Valley, have not received so much attention from the Members as they deserve. A well executed drawing of this district has been received from Mr. Scriven Bolton. The Director has examined these objects on every available opportunity, and has secured several sketches. The one which accompanies this report (Plate II., Fig. 1) was made 1901, April 30, when this district was favourably situated with regard to the terminator. On this occasion there was noticed for the first time what appears to be a prolongation of the Great Winding Valley. On existing maps the valley is usually shown as terminating, in respect of its eastern end, at the high ground east of Herodotus. The sketch, however, shows that it cuts through the mountainous ridge before mentioned, and then bends sharply to the north and skirts the ridge in question. This continuation is marked ϕ; a further rill marked ξ was seen running N. to S. Its northern termination could not, however, be seen, because it entered the shadow caused by the mountain ridge shown; possibly it joins ϕ.

Neison shows a much shorter rill in the position of ξ, discovered by Schmidt (154), and said to be difficult.

The surface of the ground contained within the horns of the crescent, formed by the Great Winding Valley, has been seen on two occasions covered with a multitude of minute hillocks, some of these being very bright, but only one craterlet, marked 5. A good deal of attention has been given (by the Director) to the Great Winding Valley (Schrœter's). On 1901, February 1, the bottom was seen to be uniform in colour, and bright, but very much broken in its continuity, and obstructed at the spot marked A. At B there is a broad enlargement, the valley running round an island-like rounded eminence.

Neison shows a craterlet on the summit of the wall of Aristarchus at its S. end. Near this position the Director has seen, under very favourable conditions, a bright peak casting a small but distinct shadow (1901, March 3). On this occasion, the floor of Herodotus being clear of its normal shadow, a narrow dark line was seen under the W. wall, but separated from it by a bright line, which may be a rill or the top of an undercliff; also a bright patch was seen for the first time at the S. end of the floor running partly across from W. to E.

Reference may be made at this point to a series of most interesting observations by Prof. W. H. Pickering, which are detailed at length in the Vol. 32, Part 2, of the Harvard College Observatory Annals before alluded to. Just E. of the broad

enlargement of the Schrœter Valley at the spot marked B he has detected seven minute craterlets. (These could be seen only in a powerful telescope.)

On various occasions some of these craterlets were found obscured by a whitish cloud or mist, whilst the others were clear and distinct. Again, some of those previously obscured would be visible whilst those previously seen would now be obscured, the covering and uncovering of these objects followed no regular law, and the Professor naturally ascribes the appearances as due to the volcanic eruption of vapour.

Prof. W. H. Pickering says: "The most marked of these "changes depend for their existence upon the altitude of the "sun, for apparently no volcanic activity whatever is exhibited "until one or two days after sunrise. The activity then increases "to a maximum, diminishes, and finally ceases a few days before "sunset. The changes thus produced are naturally very marked; "but besides these others are found to occur, which can be "differentiated from them, and which seem to be quite as spas- "modic and quite as unamenable to any apparent law as any "volcanic phenomena that occur upon the surface of the earth. ". . . . The conclusion that I draw from my observations "of these shifting white objects, is that we have here true clouds "of vapour carrying possibly ice crystals, arising from true lunar "volcanoes, which are at the present time in a state of activity."

These observations of Prof. Pickering's, taken in conjunction with those of M. Charbonneaux and the many anomalous appearances seen on the moon which have been recorded from time to time, lend additional support, if it were needed, to strengthen the theory of our sateltite possessing some kind of atmospheric covering, however rare it may be.

Atlas.

Mr. H. G. Tomkins has secured some observations of this interesting formation which confirm most of the rills shown in Capt. Molesworth's sketch in the last report. Mr. R. Hodge is also able to confirm η, ϕ and another rill there shown. There is still a good deal of detail on the floor and walls of this object which requires mapping.

Dr. H. Whichello has also sent in several admirable pencil sketches of Atlas.

Some interesting observations on the dark spots and other details on the floor of Atlas were made by Prof. W. H. Pickering during the months of January and March 1893. In the southern spot A, Prof. Pickering has seen several craterlets, one near the centre of the spot and several smaller close by, also one in the centre of the northern spot, B, which he estimates has a diameter of $0''\cdot3$. These, and several fine rills and two river beds which he depicts, are such delicate objects as to require the best instrumental aid and fine definition to detect them; the Director is not aware of any other observer having seen them previously. It would be very desirable if some of our Members would try to confirm their existence. Sketches showing these

objects are given in Vol. XXXII., Part 1, of the Annals of the Harvard College Observatory.

Prof. Pickering finds also the interesting fact that not only do the two spots, A and B, vary in size, which is well known, but that spot A has darker tints within itself. In regard to the variation in the size of A, he finds that "a general reduction in "the size of the spot begins between the 8th and 11th days after "sunrise, and consists in a gradual fading out of the outer "regions."

Cleomedes.

In the last report of the Lunar Section, particulars are given of several rills recorded by Capt. Molesworth. These have been looked for on several favourable occasions by the Director, but with negative results.

They are evidently very delicate objects, and naturally not so easily seen in this country as in the clear air of Ceylon. Capt. Molesworth's rill, running diagonally across the floor N.E. to S.W., has been seen as a ridge by Mr. R. Hodge (1900, October 10).

The Director also saw the same object as a faint light streak (1900, December 7), and subsequently on 1901, March 24. This object, whether ridge or rill, is marked ϕ in the sketch, Fig. 2, Plate II. The occasion on which this sketch was made was a very favourable one, and several interesting details were noted. The central mountain was observed to consist of two parts; a shallow crater-like object was seen at the S.W. end of the wall marked E.; a detached mountain mass (*b*) is evidently of the nature of a landslip from the wall. No trace was found of the third crater mentioned and figured by Neison as contiguous to A and D. Evidently it does not exist, unless the shallow formation F is the object he intended to indicate. The objects numbered 2, 4, 6, and 8 are crater pits—4 and 6 being very difficult; 8 is to be seen only when it is clear of the shadow of the W. wall. Two coarse rill-like valleys were also seen just outside the S.E. wall.

The central mountain in Tralles is a very remarkable object, consisting of three pear-like ridges side by side, and it is probable that further observations may show these to be really three parallel elongated crater cones. An ear-shaped projection from the S.W. wall of Tralles was seen for the first time on this occasion.

The Cauchy Rills.

Mr. J. A. Greenwood has given some attention to the region near Cauchy, and points out some interesting discrepancies in Neison's and Elger's maps. For instance, Neison figures two straight rills S.E. of Cauchy marked δ (S. 18), which Elger says are really two ridges (δ has, however, been seen as an undoubted rill by the Director, 1893, March 21). Mr. Greenwood has drawn a rill to the N.W. of Cauchy, parallel to δ and between Cauchy and D (Neison's map), and thus confirms Elger. He

also shows a crater he marks D 1, which is not shown by Neison or Elger, which is very remarkable, as Mr. Greenwood says, it is quite as large as D ; it is situated to the N.W., midway between B on Neison's map and Cauchy.

Dr. H. Whichello has examined this region, and sends a sketch, dated 1901, May 22, showing δ as a ridge, and the rill between Cauchy and D, also D 1.

It is curious that δ should sometimes be seen as a rill and at others as a ridge. Further examination is evidently necessary to ascertain its real nature.

Copernicus.

By CHARLES F. SMITH.

The illustration of this formation, Fig. 4, Plate II., is taken from a drawing made with a 5¼-in. reflector, power 200, the surrounding region being filled in from one of Rutherford's photographs under the same illumination. In representing a walled plain like Copernicus, it is more satisfactory to include as large an area of the surrounding region as possible, and this can be most easily and accurately done by utilising a photograph under the same solar altitude. Details in the surrounding country are not of great importance; what is chiefly required is to show the relationship of the crater to the country round about, and to bring out their respective characteristics. Copernicus has naturally received a considerable amount of attention from Lunar observers, but, without doubt, a large amount of work can still be bestowed upon it with advantage, so great is the amount of detail shown with a moderate aperture. The principal illustrations published are those of Neison, Herschel II., Secchi, and Nasmyth. Neison's view, taken the day after sunrise, is a very good one, and shows a considerable amount of detail, a high power and considerable aperture being used. A drawing is published in Herschel's "Outlines," which Webb says is Copernicus, but it appears to be a very general view, and by no means accurately represents the formation, although pictorially it is very pleasing. The same may be said of Nasmyth's illustration, which gives an admirable general view, but includes much detail not visible in the telescope. Secchi's drawing, published in Johnstone's Astronomical Atlas, and elsewhere, is in fair agreement with others, but shows the central mountains much too small. Many other drawings have no doubt been published, but these are probably the best known.

The magnificent appearance of this formation is very largely due to its almost isolated position on flat country, above which it rises more or less abruptly. The walls are of extraordinary thickness from the foot of the interior slope to that of the exterior. The illustration also shows the convexity of the outer glacis—a feature not by any means uncommon in walled plains, but one which is seldom delineated. It is, of course, prominently noticeable only at a certain stage of illumination. The region surrounding the crater is of considerable interest, being probably of more recent origin than Copernicus. A study of the district seems to show that the crater stands upon an island of older crust

almost submerged by the surrounding (and newer) mare; it will be seen from the illustration that the sea approaches very close to the W. and N.W. walls. Close to the W. wall will be seen some dark enclosed areas, the appearance of which might suggest their being the interiors of "ruined" formations. There are many markings of this nature extending for a long distance to the N. and N.W., which come out very clearly under a high sun.

The chief details shown on the formation itself may be briefly mentioned. Two parallel ridges start from the S.W. glacis, following the contour of the wall for some distance and then trending N.W., the end of the more easterly one being cut into sections, apparently by radiating ridges. To the N. of the N. wall is shown a dark circular mark, like a flattened ring-plain. A curved ridge starting from the S.W. corner in a S.E. direction, turns completely round a little to the N. of the well-known twin craters to the S. of Copernicus. The inflection of two sections of the wall on the N.E., as mentioned by Elger, is shown in the drawing.

Endymion.

A fine sketch—reproduced in Fig. 3, Plate II.—of this ring-plain has been sent in by Mr. Scriven Bolton, dated 1901, April 21. The interior is shown almost filled with shadow, excepting a bright triangular patch which he marks A, and which is evidently an elevation above the level of the floor. It is difficult, however, to identify it with any of the white spots mentioned by Captain Molesworth in the last report of the Section.

Captain Molesworth makes on his chart a *central* white spot, which he says is the most conspicuous object on the floor. This has been seen by the Director (1901, May 22) as a whitish mound. Unfortunately no further notes on this interesting formation have been received from Members.

Grimaldi.

Beyond the fact that this vast ring-plain presents a darker surface than any other lunar object, little seems to have been noted. Elger states that beyond "the ring-plain B, situated at "the foot of the N.E. wall and a few longitudinal ridges, just "visible under a very low sun, there is apparently no other "object to vary the monotony of this vast expanse," and Neison's details are only a little more comprehensive. "The dark interior "is traversed by a considerable number of very low, broad ridges, "and is crossed by a fine rill ξ, discovered by Schmidt, and on "the S. is a second ϕ." This object was one of those given in the circular to Members in 1897 to be carefully observed for detail on its surface, but unfortunately no notes have come to hand. This is not altogether surprising, as, although a large amount of detail does exist on the surface of Grimaldi, it is very evanescent in its visibility, and the Director has examined it frequently with only negative results. The suggestion now made, that this detail can be seen only for a short time, is borne out by the fact that our

foremost selenographers have given but scanty records, as already mentioned. The best time to scrutinise the floor is when the terminator practically bisects it, for, when once the floor is completely within the terminator, the details easily seen two or three hours earlier are mostly invisible.

The sketch reproduced in Fig. 1, Plate III., is one made at the telescope on 1901, October 25, $8^h\ 30^m$ to 9^h. When Grimaldi was fortunately situated in the position described, the E. wall was visible only for its northern half, showing that the southern half is lower and not fairly uniform, as has been stated. From the foot of the E. wall to almost the centre of the floor it was in shadow, caused by its convexity, which was well marked. To the W. of the centre a good deal of detail could be made out with a power of 250 on a 12-in. speculum, and as the shadow retreated rather quickly, showing that the convexity is not great, more detail came into view on the eastern side.

Referring to the sketch, the objects marked ξ and ϕ, described by Schmidt as rills are, as a matter of fact, ridges, and were so seen all the time, their bright upper surfaces standing out clear of the shadow. It may be here stated, in parenthesis, that several other rills on the moon, so called by Schmidt, have been seen only as ridges. The object marked ϕ is a ridge running W. from a mountain mass.

ξ is a ridge from B to a small crater on the N. wall; running S. from B is another similar ridge (13). To the S.E. is a low, rounded hill (15), very dark in tint. Between this and the massive and rugged undercliff inside the E. wall at this part are two isolated peaks, Nos. 17 and 19.

There is a curved horseshoe ridge on the W. side, marked 11, whose circular form is roughly completed by a chain of isolated hills and mountain masses. A similar incomplete ring is found on the E. side, marked 9. Besides ϕ there are two other longitudinal ridges running S. to N., numbered 3 and 5, and a cross-ridge joining 3 and 9, marked 7; all these objects were seen as faint light markings, and gave the appearance of ridges rather than rills. Their roughly circular form in two cases supports this view. The ridge 7, joining 3 and 9, was the most difficult to see. A number of hills were seen, especially to the N. end, but only one craterlet. The positions of all these objects are only approximate and require confirmation, but it is evident that there is a good deal of useful work yet remaining to be done in connection with the details on the floor of Grimaldi.

Linné.

Since Schmidt's startling discovery in 1866 that Linné no longer corresponded to the description given by previous selenographers, this object has had a fascinating interest all its own, and though it has been carefully scrutinised by many since 1866, Schmidt's description of its appearance then, as a mountain in the centre of a white spot, still accurately describes its present appearance.

In the last report the Director records seeing Linné (1894, February 27) as a bright hillock casting a shadow, but without any crater-opening on its summit, and as being situated on a small greyish surface marking, which gave the impression of being a shallow saucer-like depression.

This description, it will be seen, is borne out by the sketch, Fig. 2, Plate III., made by Mr. Hy. Corder, 1900, January 7. The saucer-like depression alluded to is evidently all that remains of an ancient crater ring. Is it conceivable that this ruined object is all that remains of the original Linné described by the older selenographers?

There is also a similar ruined formation to the S., and curved ridges abound in the vicinity. In his interesting sketch Mr. Corder shows and calls attention to two curious rounded bubble-like elevations to the N. of Linné. On 1901, March 26, the Director was fortunate enough to see Linné in the same position with respect to the terminator as shown in Mr. Corder's sketch, and was able to confirm all the details shown therein. On the next night (March 27) the place of Linné was seen as a bright spot, no cone being visible on its surface, and the formation, on whose edge Linné stands, being very indistinct. Dr. H. Whichello has also seen Linné at sunrise as a cone with a diameter of one-sixth of the white spot on which it stands (1901, May 25).

Prof. W. H. Pickering has devoted a good deal of attention to Linné and its surroundings, and the results of his observations are given in the volume of the Harvard Annals, referred to in the introduction to this Report. Prof. W. H. Pickering, in a recent letter to the Director, again calls attention to the result of his observations, which show that, in common with some other white spots on the moon, that upon which Linné stands varies in diameter according to the time it has been exposed to the sun's rays. He found that when it was first exposed to the sun it was 4″ in diameter but uniformly diminished day by day until the eighth day after sunrise (which corresponds approximately with the time of full moon,) when it was 2″·2. It then steadily increased until just before sunset, when it was 3″·5.

Prof. Pickering is also of opinion, from a comparison of the photographs, drawings, and micrometrical measures, made between 1866 and 1897, that there has been a steady and permanent decrease in the size of the Linné spot, from about 7″ to 3″·91 in diameter.

Prof. Pickering is anxious that his results in respect of the monthly increase and decrease of the white Linné spot should be tested. Micrometrical measures of the N. and S. diameters on every evening possible during one lunation would be sufficient to settle this point.

Marius.

Mr. Scriven Bolton has sent, in addition to many other most admirable sketches of lunar formations, sketches of Marius which he has had under observation for some time. One of these

sketches, taken under morning illumination, dated 1901, January 2, is reproduced in Fig. 4, Plate III.

It shows a new feature in the ridge running down the centre from N.W. to S.E. In another sketch Mr. Bolton shows a central mountain strongly defined, but whose presence his later sketch does not more than suggest. In the second sketch a roughly triangular dark patch is seen having its apex at the central hill and its base along the E. wall.

The Director has seen (1901, April 1) this low central elevation and the triangular dark patch, but the base line was extended in either direction N. and S. along the foot of the E. wall. Its existence may possibly be the result of the convexity of the floor of Marius.

On no occasion as yet has Mr. Bolton's longitudinal ridge been seen.

Messier and Messier A.

With the exception of a pencil sketch by Mr. J. H. Bridger, dated 1899, August 23, under evening illumination, no notes or sketches have been received.

On account of the small size of these objects they require fairly powerful telescopes to reveal much detail in their structure, but to one provided with such an instrument they present problems for solution of the deepest interest and importance.

The question of an actual physical change having occurred in the forms of one or of both of these twin craters has never yet been satisfactorily answered.

In the Harvard Observatory Annals, previously mentioned, Prof. W. H. Pickering has a most interesting and exhaustive report of observations made by him in 1891, and continued in 1897-8. To give some idea of the amazing complexity of the problem these craters present in their constantly changing appearances, reference should be made to the original report of Prof. Pickering itself—our space is far too limited to give even an outline of it. The following extract from a letter received from Prof. Pickering to the Director will serve to emphasise this point :-

Speaking of the work our Lunar Section might take up, he kindly says : " Another piece of work I would suggest to those " who have no clock-driven telescope or micrometer, is a study " of Messier and Messier A. These craters will sometimes be " found elliptical, as described by Neison, sometimes triangular, " as described by Elger. When elliptical their major axes are " sometimes parallel, sometimes perpendicular, and sometimes " inclined ; sometimes one is larger, sometimes the other. They " are most interesting when the libration favours the western " limb, as their changes then show to the best advantage. " Between the 6th and 8th day after sunrise it is impossible to " predict their shapes, which are generally irregular and vary " in different lunations. An aperture of 5 or 6 inches is best for " this work, but 3 inches will show the changes."

Prof. Pickering suggests that drawings should be made, especially between the 6th and 8th days, corresponding to co-longitude of sunrise terminator between 25° and 50°, and a statement should be made on such drawing giving the relative areas of the craters thus:—Messier A = 1·2 × Messier. When elliptical the inclination of the major axes to the lines joining their centres should be given.

Miscellaneous Observations.

A number of miscellaneous observations have been received from Members of the Section, from which the following are selected.

Mare Crisium.

The Rev. H. Wadsworth sends a finished sketch of the S.E. side of this formation at sunset, 1898, December 23, showing interesting detail from the E. wall across the Mare to the terminator just W. of Picard.

Ariadæus Rill.

This remarkable rill has been sketched by Dr. H. Whichello, 1900, June 7, and also by Rev. H. Wadsworth. The latter directs attention to the curious manner in which the continuity of the rill is interrupted by mountains, and does not apparently pass through them as is usually the case in similar circumstances. He suggests that the mountains are of more recent formation than the rill.

Dr. Whichello has been very active in making sketches of different formations, of which about 30 have been sent in. These illustrate, among other objects, rills and ridges near Cauchy, the west wall of Hipparchus, Posidonius, and several of Atlas.

Billy.

Prof. Comas Sola has sent several interesting and well-finished drawings; one of Billy, dated 1900, March 13, is reproduced in Fig. 3, Plate III. It shows the two well-known light spots at the S. end of the floor, whose character yet remains to be determined, though in this case they are shown as slight elevations. The sketch shows also a diffuse white marking at the north end of the floor, previously seen by Capt. Molesworth and the Director.

Reiner.

A most interesting sketch of Reiner by Prof. Comas Sola is reproduced on Plate IV., and shows some variations from the description given by Elger, and in comparison with the drawing in Krieger's "Mond Atlas." Both these authorities report a ridge,

or ridges, running from the N. and S. walls, and Elger mentions the continuation of these across the floor. Prof. Comas Sola shows neither of these, but gives the walls as being surrounded by a bright nimbus. Several bright hills are shown to the E., which Elger and Neison do not mention. The meridional ridge they speak of as being very distinct.

Doppelmayer.

A very fine sketch of this formation under morning illumination has been received from Mr. Scriven Bolton. It is reproduced in Fig. 1, Plate V., and shows a large amount of detail on the floor, besides the well-known central peak A. It shows also the low N.W. wall now almost razed to the level of the plain, and the shallow crater C to the W. of Doppelmayer, described by Neison as being visible only with considerable difficulty. Mr. Bolton shows a central elevation which Neison does not mention. The sketch depicts, too, the companion crater Lee, with its likewise ruined N.W. walls, but does not show the central peak mentioned by Neison. It shows, however, a curved ridge running from the N.E. wall to the centre of the floor and terminating at a mountain; a similar curved ridge from the S.E. wall almost meeting it. These ridges form a roughly circular enclosure within the walls of Lee itself. None of the many hills mentioned by Neison are shown on Mr. Bolton's sketch.

Wargentin.

This remarkable and unique formation has also been drawn by Mr. Scriven Bolton, whose sketch is reproduced in Fig. 2, Plate V. The low longitudinal ridges are well shown, as well as a number of small craters to the W. omitted in Neison's map.

Obscure and Partially Destroyed Ring-Plains.

In continuation of the series of these interesting objects, which belong to a very early period in the history of the moon, the Director has secured a number of additional examples of the same class, sketches of which are now reproduced.

Plate VI., Fig. 1.—Shows that there are several bays in the N.W. side of the Riphæan mountains, which bear evidences of once having been completely ringed plains, but whose N.W. walls have been razed to the level of the Mare Nubium. The small crater Euclides is surrounded by low ridges, whose roughly circular forms suggest, without doubt, that they are the remains of the ramparts of a large mountain-ringed plain. South-east of this is another horse-shoe shaped formation which was once a circle.

Fig. 2.—N.W. of Hansteen is another horse-shoe formation, with low walls, and quite apart, to the N., the dotted line showing where the original wall probably stood; it is marked *e* in Neison's map, but he makes no reference to it in the text.

Neison, however, mentions the curved mountain ridge from E. to N. in connection with the mountain ring which the sketch suggests, but does not depict or mention the low central hills, whose remains are shown, or the two craters to the S.W. of the ring which were conspicuous objects when the sketch was made.

Fig. 3.—Shows two most interesting groups of ruined ring-plains south of Posidonius on the W. side of the great serpentine ridge which borders the Mare Serenitatis. This ridge is most inadequately depicted in Neison's and Elger's maps. The form now shown is the result of a careful sketch made 1901, May 23; the other series of ruined ring-plains is shown to exist to the S. of Vitruvius.

Fig. 4.—N. of Atlas, Neison mentions the partly enclosed formation marked *e*, but does not mention the central hill, which at once shows that *e* was at one time a complete ring plain. He depicts some portion of the remaining walls of another ruined ring plain to the E. of Endymion *a*. The object to the N. of Endymion is De la Rue in Neison's map; but it is difficult to identify this region on his map with its appearance as seen in the telescope. Neison mentions a central hill, but on the occasion when this sketch was made it was seen to consist of three separate peaks.

Fig. 5.—Shows several interesting partly ruined ring-plains on the E. side of the Mare Crisium. As has been previously pointed out, this class of object is found most frequently on edges of the various Lunar *Maria*.

Plate VII., Fig. 6.—At the S. end of the Straight Wall near Birt are several ruined ring plains. The one marked B was first pointed out by Dr. H. Whichello; the others, A and C, are taken by the Director from a photographic enlargement.

Fig. 7.—Shows a most interesting group of isolated hills arranged in a roughly circular form and very suggestive of an old ring-plain. These objects are seen well only when near the terminator, and will repay a careful inspection. When so situated, such an assemblage of isolated peaks as are here shown is probably unique on the moon. Elger makes no reference to this interesting group, and Neison merely mentions that S. of Euler are some moderately high peaks, forming a rough circle. The crater marked B is not shown by Neison.

Fig. 8.—Shows an incomplete ring plain as large as Archimedes, of which only the N. wall, in the shape of two ridges, is left.

Fig. 9.—S.W. of Lubiniezky are two irregular circular-like formations with low walls, and to the N. three others. Number *a* is shown in Neison's map clearly as an enclosure, but the horse-shoe formation near it and the ruined formation, on the rim of which the crater B stands, are not so indicated. This latter is a very good example, only two curved ridges being eft, the N. and S. walls having entirely disappeared.

Fig. 10. With the exception of D, the details are taken from a Paris photograph, and form a roughly circular chain of hills and craters, with a central crater A., not shown by Neison or Elger.

The crater E does not appear in either of these maps or in the photograph. It was first seen by the Director, 1901, April 24, on which occasion the enclosure D was also seen.

Fig. 11 shows the well-known curved mountain ridges round Torricelli. The circle of the wall under favourable conditions can be seen complete, but those parts shown by dotted lines consist of banks of very low elevation. A is a roughly circular assemblage of ridge-like hills, with evidences of a central peak, and B is similar in character. These objects are well shown, and have been copied from a Yerkes photograph recently taken of this region.

Outline Maps.

The four outline maps, drawn from photographs by Mr. B. E. Cammell, which embody the results of the measured points on the same by Mr. S. A. Saunder, M.A., F.R.A.S., represent such an amount of original, valuable, and arduous work, that it has been deemed most essential that they should be preserved in a permanent form, hence they have been reproduced in this report on Plates VIII. and IX. As now shown, they are only one quarter of the size of the original copies issued to the Members of the Section, which were on a scale of 200 ins. to the moon's diameter.

Reference to these maps will be found indispensable in connection with Mr. Saunder's paper on "Some results obtained "from the Measurements of Lunar Photographs," on page 89.

Occultations.

The two following observations have been sent in by Mr. C. L. Brook, M.A., F.R.A.S., as seen by him at Meltham, Yorks.

"1900, November 9. χ^1 Orionis, magnitude 4·7, predicted near approach in the N.A., but occulted at Meltham. Disappearance $9^h\ 45^m\ 31^s$ G.M.T. (rather uncertain). Reappearance $10^h\ 4^m\ 40^s$ quite certain to within 1^s; reappearance not instantaneous, but in two steps about $\frac{1}{2}^s$ apart.

"1901, April 23, DM. + 18°1349. Occulted $7^h\ 56^m\ 34^s$. One quarter of the light first disappeared and two seconds elapsed before final disappearance. Dark limb very distinct."

Anomalous occultations are of frequent occurrence and hitherto have been explained by the supposed passage of the star behind some mountain peak on the limb, when the star's motion was tangential to the limb, and reappearing again in the valley at the foot of the mountain before disappearing finally. It has also been urged that refraction of a low-lying lunar atmosphere has been the cause of the non-instantaneous disappearance of stars occulted; and also that such anomalous occultations were of the nature of optical illusions.

In the "Monthly Notices" of the Royal Astronomical Society, April 1901, Mr. T. A. Innes, of the Cape Observatory, discusses a much more probable theory. His suggestion is that, when a star disappears in two stages or glides behind the limb, it is *prima facie* evidence that the star in question is in reality a double star. Mr. Innes gives a list of anomalous occultations, many of which he has observed himself, in support of this theory. He also

points out that in former times the duplicity of stars in several instances was first discovered by watching their occultation. His paper is a valuable and interesting contribution to the solution of a much-vexed question. It is too long to quote from extensively, but the following paragraph may be given as showing the nature of the double stars in question :—"The probability is "that many of the stars, whose duplicity is shown by occultation, "will be found too close for telescopic confirmation, and will "therefore form a class intermediate between the visual double "and the spectroscopic binary."

An interesting observation of a star of this class is to be found in the "Journal" of the British Astronomical Association Vol. III., page 187.

Mr. C. L. Brook's two observations at the head of this chapter point very strongly in the direction of the duplicity of χ^1 Orionis and DM. + 18° 1349.

The Director hopes that, as small telescopes can be usefully employed in watching occultations, many more notes on them may be received in the future.

Ptolemæus.

In the last report on the Lunar Section a map of this formation appears. Since that publication further results have been obtained, and these are embodied in the chart reproduced in Fig. 1, Plate X.

Mr. Saunder's paper, which follows, under this heading, is a further valuable contribution to the completion of the ultimate monograph which it is hoped to produce in due course. A great amount of work still, however, remains to be done, especially in connection with the mapping of the light-streaks on its surface. A welcome contribution in this direction has been made by Mr. W. J. Hall, and the streaks he has sketched are inserted in the chart now published. They represent the result of observations made on eight nights in 1900, November and December, and 1901, January.

The dark well-known triangular marking across the S.E. part of the floor should be watched closely, as Mr. Saunder suggests the probability of it changing in size during the progress of each lunation.

Ptolemæus.

By S. A. SAUNDER, M.A., F.R.A.S.

Work on Ptolemæus was continued until 1900, February, since which date all available nights have been devoted to determining the positions of formations required for the reduction of the lunar photographs. Considerable progress has, however, been made since the last report, and in the map now given not only are a number of new formations shown, but several of those which were copied into the last map from the one given in "Memoirs," Vol. III., part 5, have been measured and their positions amended. As before, the measured formations are distinguished by a line under the corresponding symbol.

It was noted in my last report ("Memoirs," Vol. VII., page 66) that there was a discrepancy between the absolute positions of

Ptolemæus A and the cone of Herschel found by Neison and Lohrmann respectively, and my own measure of the distance between them, and that in the construction of the map I had adopted the position of Ptolemæus A as given by Neison. Since this was written I have myself determined the absolute position of Ptolemæus A by measurement from Mösting A, and Prof. Barnard has most kindly taken for me a similar set of measures on two nights, with the full aperture of the Yerkes 40-inch refractor and a power of 700 diameters. An account of these measures is given in the "Monthly Notices" of the Royal Astronomical Society, Vol. LX., page 540. (*See also* "Astronomical Journal," Vol. XXII., page 33.) The resulting place from Prof. Barnard's measures is—

$$\xi = - \cdot 0142 \qquad \eta = - \cdot 1479$$

that from my own measures being

$$\xi = - \cdot 0139 \qquad \eta = - \cdot 1478.$$

These are in very satisfactory agreement,* but show a relatively large divergence from Neison's position, which was

$$\xi = - \cdot 0168 \qquad \eta = - \cdot 1492$$

I have also measured the position of the cone of Herschel at the telescope on three nights, whence I find (M.N., Vol. LX., page 182)

$$\xi = - \cdot 0370 \qquad \eta = - \cdot 0990$$

and on the two photographs referred to in another part of this report, which give

Plate II. $\xi = - \cdot 0374 \qquad \eta = - \cdot 0990$
Plate III. $\xi = - \cdot 0373 \qquad \eta = - \cdot 0988.$

These are in satisfactory agreement with the telescopic measures, and do not differ much from Lohrmann's position

$$\xi = - \cdot 0374 \qquad \eta = - \cdot 0979$$

If we adopt Prof. Barnard's position of Ptolemæus A and my own place for Herschel as found at the telescope, the telescopic places being, I think, at present superior to the photographic, the resulting distance between the two formations would, at mean distance of the moon, be $50''\cdot 3$. This reduces the previously noted discrepancy from $1''\cdot 9$ to $0''\cdot 5$, and is as close an agreement as the nature of the work would lead me to expect.

The adoption of the new positions will necessitate a revision of all the absolute places given in the last report, but the relative positions will not be affected.

I hope before very long to be able to resume the work on Ptolemæus, when this, together with a reconstruction of the whole nomenclature in accordance with the rules adopted by the Section, will demand attention. In the meantime the meridians and parallels are omitted from the present map.

The boundary of the dark area on the N.E. portion of the floor has been advanced in accordance with further observation. I expect that this boundary will be found to vary, as has been noted in the case of other dark patches, and would suggest this as a subject for observation by Members of the Section.

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* They are also in close agreement with the position found by Dr. Franz, and published in Vol. I. of the Breslau "Mitteilungen," which gives—

$$\xi = - \cdot 0138 \qquad \eta = - \cdot 1480.$$

On some Results obtained from the Measurement of Lunar Photographs.

By S. A. SAUNDER, M.A., F.R.A.S.

At the November Meeting of the Association some account was given ("Journal," vol. xi., p. 60) of the preliminary steps which had been taken for the purpose of constructing the four outline maps then being prepared for the use of the Lunar Section. I now give a list of the measures there referred to, as it seems desirable that these should be rendered available for future reference.

The plates on which the measures were made are two positive copies on glass, kindly made for me by Mr. Bellamy, of the Oxford University Observatory, from two Paris negatives, for which I am indebted to the generosity of M. Loewy. Réseaux were impressed on the copies, and the measures were made with an astrographic micrometer of the pattern in use at Greenwich and Oxford, the property of the Oxford University Observatory, and kindly lent to me for the purpose by Professor Turner. The reductions were made as described in a paper read before the Royal Astronomical Society ("Monthly Notices," vol. lx., p. 174), but with improved plate constants obtained by methods of which I hope before long to publish an account.*

The particulars of the plates are as follows:—

Reference Number.	Date.	Librations.		Approximate Longitude of Terminator.
		l'	b'	
II.	1899, Feb., $18^d\ 6^h\ 30^m\ 14^s$, Paris sid. *t*.	$+ 5° 1'·7$	$- 1° 57'·2$	$- 11°$ M.
III.	1895, Sept., $9^d\ 1^h\ 38^m\ 2^s$, Paris sid. *t*.	$- 6° 34'·4$	$- 5° 53'·6$	$+ 18°·5$ E.

The accordance between the two sets of measures will, I hope, appear satisfactory when compared with results obtained by measurements from the limb, whilst I am not aware that anyone has ever before attempted to measure so many points in so small an area. In fact, the labour required for a complete reduction would have been practically prohibitive, so long as it was necessary that all measures should be made on the moon itself. The number of points here given is 74, very little less than half the number, 157, on which Schmidt's map of the whole lunar surface was based, whilst the area covered is only $(·21)^2/\pi = ·014$ of the projection of the visible hemisphere. This number might have been increased had I measured points which were visible on one only of the plates, but in order to avoid risk of error, it seemed better to include those only which were measurable on both. When more plates are available, it will be possible to add to the list, but, if the present density were maintained, the total for the whole surface would exceed 5,000.

* For this, *see* "Monthly Notices," vol. lxii., p. 41.

In measuring lunar formations it is certainly not at present possible, and one may almost be allowed to doubt whether it ever will be possible, to attain to stellar accuracy, but only about 10 per cent. of the discordances noted below amount to more than ·0005 of the moon's radius. This quantity corresponds to a little less than half a second of arc, or to $\frac{1}{20}$th of an inch on the large scale maps now in the hands of Members of the Lunar Section. It would require very careful measurement to detect an error of this magnitude on the map.

Many of the larger discordances may, I think, be accounted for in one or other of various ways. Some are due to the measured formations not being suitably illuminated on one of the plates. Thus, on Plate III. Ptolemæus G2 and Hipparchus M are almost entirely immersed in the shadows of the walls of Ptolemæus and Hipparchus A respectively. I have very little doubt that the measures of these points on Plate II. are more accurate than those on Plate III. Others, as in the case of Halley α and Rhæticus γ, are due to the want of such an intimate acquaintance with the particular region as is required to locate the summit of a peak when the shadow is not very clearly defined. Hipparchus F2 is an irregular formation, pretty clearly defined on Plate III., but hardly discernible on Plate II. In this case the more accurate place is probably given by Plate III.

Now the object of the measures was to assist in the construction of the outline maps, and for this purpose a measure in error by as much as a second of arc is better than no measure at all. Accordingly, everything has been included which could be measured on both plates with anything like this degree of approximation.

Two points, Hipparchus C and Hipparchus G, have been measured at the telescope from Mösting A as origin, as described in the paper already referred to ("Monthly Notices," vol. lx., p. 174). It is on the accordance between these results and those obtained from the photographs that the claim of the latter to give absolute, and not merely relative, positions must be ultimately based. This point I hope to discuss when describing the method finally adopted for determining the plate constants.*

Reduced copies of the maps are published to facilitate identification of the points, but I do not wish the symbols by which I have denoted them to be considered as anything more than a means of identification on the map. The question of lunar nomenclature is in a most unsatisfactory condition, as anyone knows who has had occasion to determine to which of all the surrounding formations an A or a B he finds on a map may belong; and, whilst I believe that the plan proposed by Dr. Richards and referred to in our "Journal" (vol. xi., p. 64), is the best yet suggested, I am sure that the boundaries of the regions and the distinctive symbols for the separate formations can be satisfactorily assigned only after an exhaustive study of the region itself at the telescope. It is to be hoped that some Members of the Section will devote themselves to settling a suitable nomenclature for that part of the surface now under consideration, and I should be very

* *See* "Monthly Notices," vol. lxii., p. 56.

sorry if they considered themselves in any way hampered by the symbols here temporarily adopted.

In the following table the places are given in the usual rectangular co-ordinates, the axis of ξ being the projection of the moon's equator when seen under mean libration. The suffixes 2, 3, denote that the corresponding values of ξ, η were obtained from Plates II. and III. respectively. In determining the mean values of ξ, η, when the last figure is doubtful I have been guided by the fifth figure, which was retained throughout in the computation, but rejected in the final result as worthless. To the mean values of ξ, η, I have added the corresponding value of ζ obtained on the supposition that $\xi^2 + \eta^2 + \zeta^2 = 1$.

Table showing the Results of Measures made on Plates II., III.

Symbol.	ξ_2.	ξ_3.	$\xi_2 - \xi_3$.	η_2.	η_3.	$\eta_2 - \eta_3$.	Mean ξ.	Mean η.	ζ.
1. Reaumur ζ -	−·0049	−·0052	+·0003	−·0365	−·0366	+·0001	−·0050	−·0366	+·9993
2. Reaumur ii. (S. end of valley).	+·0004	+·0002	+ 2	−·1122	−·1121	− 1	+·0003	−·1121	+·9937
3. Ptolemæus G 2	+·0011	+·0000	+ 11	−·1240	−·1244	+ 4	+·0006	−·1242	+·9923
4. Reaumur A -	+·0044	+·0044	0	−·0750	−·0752	+ 2	+·0044	−·0751	+·9972
5. Reaumur δ -	+·0078	+·0083	− 5	−·0268	−·0270	+ 2	+·0080	−·0269	+·9996
6. Ptolemæus H -	+·0121	+·0124	− 3	−·1618	−·1622	+ 4	+·0122	−·1620	+·9867
7. Reaumur e -	+·0176	+·0176	0	−·1024	−·1022	− 2	+·0176	−·1023	+·9946
8. Hipparchus f 2	+·0227	+·0231	− 4	−·1347	−·1348	+ 1	+·0229	−·1348	+·9906
9. Reaumur A′ -	+·0253	+·0256	− 3	−·0502	−·0506	+ 4	+·0254	−·0504	+·9984
10. Hipparchus f -	+·0259	+·0262	− 3	−·1364	−·1365	+ 1	+·0261	−·1364	+·9903
11. Albategnius G -	+·0328	+·0328	0	−·1641	−·1639	− 2	+·0328	−·1640	+·9859
12. Hipparchus r -	+·0358	+·0353	+ 5	−·1322	−·1323	+ 1	+·0355	−·1323	+·9906
13. „ F 2	+·0373	+·0365	+ 8	−·0622	−·0617	− 5	+·0369	−·0620	+·9974
14. „ r 6	+·0374	+·0372	+ 2	−·1413	−·1413	0	+·0373	−·1413	+·9893
15. „ K	+·0379	+·0375	+ 4	−·1209	−·1210	+ 1	+·0377	−·1209	+·9919
16. „ H 9	+·0412	+·0410	+ 2	−·0211	−·0218	+ 7	+·0411	−·0214	+·9989
17. „ r 2	+·0422	+·0421	+ 1	−·1372	−·1375	+ 3	+·0421	−·1373	+·9896
18. „ F -	+·0434	+·0431	+ 3	−·0728	−·0727	− 1	+·0432	−·0728	+·9964
19. „ F 16	+·0460	+·0460	0	−·0827	−·0826	− 1	+·0460	−·0827	+·9955
20. „ I 16	+·0499	+·0500	− 1	−·1475	−·1478	+ 3	+·0500	−·1477	+·9878
21. Albategnius A 2	+·0515	+·0513	+ 2	−·1970	−·1969	− 1	+·0514	−·1970	+·9791
22. Hipparchus H	+·0526	+·0528	− 2	−·0386	−·0382	− 4	+·0527	−·0384	+·9979
23. „ I -	+·0560	+·0559	+ 1	−·1317	−·1318	+ 1	+·0559	−·1318	+·9897
24. „ I 4	+·0620	+·0617	+ 3	−·1177	−·1176	− 1	+·0619	−·1177	+·9911
25. „ I 2	+·0622	+·0617	+ 5	−·1240	−·1243	+ 3	+·0620	−·1242	+·9903
26. Albategnius b 8	+·0633	+·0628	+ 5	−·1661	−·1662	+ 1	+·0631	−·1661	+·9841
27. „ b 2	+·0642	+·0636	+ 6	−·1789	−·1789	0	+·0639	−·1789	+·9818
28. „ b 12	+·0676	+·0673	+ 3	−·1592	−·1590	− 2	+·0674	−·1591	+·9850
29. „ b 10	+·0689	+·0682	+ 7	−·1651	−·1655	+ 4	+·0686	−·1653	+·9839

Symbol.	ξ_2.	ξ_3.	$\xi_2-\xi_3$.	η_2.	η_3.	$\eta_2-\eta_3$.	Mean ξ.	Mean η.	ζ.
30. Albategnius *b* -	+·0695	+·0695	0	−·1744	−·1746	+ 2	+·0695	−·1745	+·9822
31. „ *b* 14	+·0718	+·0723	− 5	−·1547	−·1549	+ 2	+·0721	−·1548	+·9853
32. „ *b* 4	+·0781	+·0778	+ 3	−·1712	−·1715	+ 3	+·0780	−·1714	+·9821
33. Hipparchus X 1 (N.E. end),	+·0803	+·0803	0	−·1004	−·0999	− 5	+·0803	−·1001	+·9917
34. Rhæticus μ -	+·0838	+·0842	− 4	−·0151	−·0152	+ 1	+·0840	−·0152	+·9963
35. Hipparchus X 2	+·0858	+·0856	+ 2	−·1056	−·1055	− 1	+·0857	−·1056	+·9907
36. „ *n* -	+·0873	+·0871	+ 2	−·0843	−·0841	− 2	+·0872	−·0842	+·9926
37. Albategnius H	+·0895	+·0889	+ 6	−·1675	−·1675	0	+·0892	−·1675	+·9818
38. Halley α -	+·0927	+·0933	− 6	−·1327	−·1326	− 1	+·0930	−·1326	+·9868
39. Rhæticus γ -	+·0948	+·0954	− 6	+·0031	+·0038	− 7	+·0951	+·0035	+·9955
40. Halley - -	+·0999	+·0994	+ 5	−·1390	−·1394	+ 4	+·0996	−·1392	+·9852
41. Horrocks -	+·1024	+·1021	+ 3	−·0689	−·0695	+ 6	+·1022	−·0692	+·9924
42. Rhæticus ξ (N.E. end).	+·1109	+·1109	0	−·0133	−·0135	+ 2	+·1109	−·0134	+·9937
43. Rhæticus (S.W. end).	+·1153	+·1150	+ 3	−·0194	−·0196	+ 2	+·1152	−·0195	+·9932
44. Hipparchus E 2	+·1189	+·1189	0	−·0566	−·0568	+ 2	+·1189	−·0567	+·9913
45. „ E -	+·1222	+·1224	− 2	−·0498	−·0498	0	+·1223	−·0498	+·9912
46. Hind - -	+·1264	+·1273	− 9	−·1373	−·1377	+ 4	+·1268	−·1375	+·9824
47. „ *c* - -	+·1287	+·1286	+ 1	−·1508	−·1514	+ 6	+·1286	−·1511	+·9801
48. Hipparchus G -	+·1288	+·1292	− 4	−·0872	−·0872	0	+·1290	−·0872	+·9878
49. „ R -	+·1291	+·1292	− 1	−·0364	−·0364	0	+·1292	−·0364	+·9910
50. Albategnius C 4	+·1328	+·1325	+ 3	−·1963	−·1963	0	+·1326	−·1963	+·9715
51. Hipparchus *m* -	+·1326	+·1328	− 2	−·0706	−·0703	− 3	+·1327	−·0705	+·9886
52. Albategnius C 2	+·1366	+·1364	+ 2	−·1876	−·1874	− 2	+·1365	−·1875	+·9727
53. Hipparchus ν (N. end).	+·1381	+·1382	− 1	−·0276	−·0276	0	+·1381	−·0276	+·9900
54. Hipparchus ν (S. end).	+·1410	+·1414	− 4	−·0354	−·0358	+ 4	+·1412	−·0356	+·9893
55. Hipparchus C -	+·1412	+·1426	− 4	−·1285	−·1285	0	+·1424	−·1285	+·9814
56. Albategnius C -	+·1430	+·1428	+ 2	−·1853	−·1854	+ 1	+·1429	−·1853	+·9722
57. Abulfeda *d* 4 -	+·1528	+·1525	+ 3	−·2071	−·2071	0	+·1527	−·2071	+·9663
58. „ *d* 6 -	+·1537	+·1533	+ 4	−·2032	−·2032	0	+·1535	−·2032	+·9670
59. Hipparchus L -	+·1560	+·1565	− 5	−·1190	−·1192	+ 2	+·1563	−·1191	+·9805
60. Albategnius C 8	+·1571	+·1572	− 1	−·1899	−·1901	+ 2	+·1571	−·1900	+·9691
61. „ λ -	+·1584	+·1579	+ 5	−·1641	−·1647	+ 6	+·1582	−·1644	+·9736
62. „ C 6	+·1582	+·1582	0	−·1778	−·1780	+ 2	+·1582	−·1779	+·9712
63. Hipparchus λ, S. end.	+·1592	+·1589	+ 3	−·0235	−·0238	+ 3	+·1590	−·0237	+·9870
64. Hipparchus M	+·1642	+·1648	− 6	−·0190	−·0193	+ 3	+·1645	−·0191	+·9862
65. „ *p* -	+·1707	+·1703	+ 4	−·0683	−·0688	+ 5	+·1705	−·0685	+·9830
66. „ V -	+·1806	+·1801	+ 5	−·0705	−·0706	+ 1	+·1804	−·0705	+·9811
67. Abulfeda C 3 -	+·1859	+·1858	+ 1	−·1989	−·1986	− 3	+·1859	−·1988	+·9622
68. Dollond F -	+·1906	+·1912	− 6	−·1447	−·1446	− 1	+·1909	−·1447	+·9709
69. „ A -	+·1917	+·1921	− 4	−·1870	−·1874	+ 4	+·1919	−·1872	+·9634
70. Hipparchus A 1	+·1924	+·1919	+ 5	−·0064	−·0066	+ 2	+·1922	−·0065	+·9813

Symbol.	ξ_2.	ξ_3.	$\xi_2-\xi_3$.	η_2.	η_3.	$\eta_2-\eta_3$.	Mean ξ.	e	ζ.
71. Dollond A 2 -	+·1938	+·1940	− 2	−·1780	−·1781	+ 1	+·1939	−·1780	+·9647
72. Hipparchus L 4	+·1955	+·1959	− 4	−·1155	−·1159	+ 4	+·1957	−·1157	+·9738
73. „ L 2	+·1969	+·1967	+ 2	−·1308	−·1311	+ 3	+·1968	−·1309	+·9717
74. „ A 3	+·2038	+·2042	− 4	−·0127	−·0133	+ 6	+·2040	−·0130	+·9789

Results of Measures made at the Telescope.

(55) Hipparchus C.

1900, April 13	-	$\xi = +·1420$	$\eta = -·1288$
May 7	-	+·1424	−·1290
Aug. 13	-	+·1423	−·1283
1901, Jan. 2	-	+·1423	−·1281
Mean	-	+·1423	−·1285

(48) Hipparchus G.

1900, Nov. 9	-	$\xi = +·1289$	$\eta = -·0871$
10	-	+·1290	−·0871
1901, Jan. 4	-	+·1285	−·0880
Feb. 1	-	+·1284	−·0878
Mean	-	+·1287	−·0875

It appears from the above results that the mean value of $\eta_2-\eta_3$ is about +·0001, and that, consequently, the relative accordance might have been improved by shifting the assumed centre by this amount on one or other of the plates. But the positions of the centres have been determined, with the other plate constants, as part of a more extended investigation, from which I hope to be able to show that measures may be made on any part of the surface with practically the same degree of accuracy as in the restricted region here considered. I have, therefore, used throughout the values given by the general investigation. It will be evident from the residuals that reliance must not be placed upon the last figure given, and it would seem that there may even be systematic error affecting just this place. But I think the results now published will lend support to my claim to have determined a trustworthy value of the third figure, or in other words, that the places now given are in error by less than one second of arc.*

* Positions are found by Dr. Franz in Vol. I. of the Breslau "Mitteilungen" for three points in this area, which give—

(45) Hipparchus	E	-	$\xi = +·1219$	$\eta = -·0501$
(48) „	G	-	+·1289	−·0874
(55) „	C	-	+·1422	−·1288

These are in close agreement with the values given above.

Theophilus.

Mr. Scriven Bolton sends several sketches (including the one reproduced in Fig. 2, Plate X.) of this remarkable and prominent lunar formation, to the mapping of which he has been devoting himself for some time past.

The plan of each lunar observer selecting some object or district on the moon's surface and devoting his attention more particularly to such, is one strongly to be commended. The accumulation of individual results in connection with selected objects, scattered over the entire disk, is one of the surest methods of adding to the aggregate knowledge of the features of our satellite. All original work of the kind carries with it its own reward.

Another example of the value of such persistent work is that now being carried on by Mr. S. A. Saunder, M.A., F.R.A.S., in reference to Ptolemæus, and that of mapping the light streaks surrounding Copernicus, which Mr. H. G. Tomkins has taken in hand.

Mr. Scriven Bolton sends some notes with his sketches, which read as follows :—

"The first sketch of Theophilus was made on 1899, December 8, and since then the work has been carried on on every favourable opportunity, a power of 400 being often employed on my $4\frac{1}{8}$ refractor.

"Most of the time has been spent in obtaining the correct shape. For determining more accurately the position of the most prominent markings a Lick photograph has been utilised.

"A scale of 9 ft. to the moon's diameter was first proposed, but it was found far too small to represent satisfactorily the minute detail on the inner slope. I therefore adopted a much larger scale. The enclosed outline map is a tracing of the drawings, showing all the details up to date. I have a lot to confirm as regards suspected craters, and others will probably be picked up. When I feel sure that these objects are mapped in their proper positions, I shall commence to fill in all detail, and get as many views as possible of certain portions of the walls, &c., under different angles of illumination. The crater now on the W. side of the floor, and the cleft on the W. inner slope, represented by Neison, have not yet been identified. One peculiarity about the inner slope is, that it is composed principally of high ridges, many of which are perfectly straight. Under certain angles of illumination some of them appear to be the summits of straight mountain ranges. There is one instance in which two of these ridges run exactly parallel to each other for more than 25 miles on either side of a deep valley, having much the appearance of a wide crater-row. The light-streaks seen at full moon are very difficult objects. At sunrise, during the April lunation, I perceived some of the same streaks running across the floor. Until then, however, I was under the impression that they were quite invisible under such circumstances. They probably mark the site of very low ridges.

"I am preparing a full-moon map; it is yet very incomplete, and details are shown only on the W. half of the floor. The air must be particularly steady before the light lines can be clearly seen. They are brightest one or two days before full moon, when the sun is at its highest altitude above Theophilus."

Practical Notes on Lunar Photography.

By J. MILTON OFFORD, F.R.M.S.

The owner of a reflecting telescope stands at a great advantage when lunar photography is attempted, for not only has he usually a large aperture at command; but the coincidence of the visual and actinic foci proves of considerable service. With a refractor the actinic focus must first be found by trial. This can be best accomplished by dividing a small portion of the drawtube and taking a number of exposures at varying focal distances; but the best focus obtainable with an ordinary refractor is not so sharp as that given by the reflector, to equal which either an additional correcting lens must be added to the object-glass, or an objective specially designed for photographic work employed. With a large aperture a screen may be used, but this greatly reduces the light, and is out of the question for the greater number of telescopes in the hands of amateurs.

To obtain first-rate results in lunar photography a clock-driven equatorial, or mechanically moved plate-holder, is essential, but fair pictures may be taken with a rigid instrument, if the light be sufficient and enlargement in the telescope is not attempted. At the focal point of a telescope working at $f/12$ the full moon may be photographed in one-twentieth of a second on a clear night, but exposures will vary greatly with the condition of the air and lunar phase.

With a clock-driven telescope enlarging lenses may be used, the size of the lunar image thus obtained being limited by the length of the camera which can be conveniently employed; unsteadiness of atmosphere will prevent any great amount of enlargement on most nights.

A Barlow lens is a good enlarger, as it gives a flat field with very fair definition, but better results, though over a smaller field, may be obtained with triple cemented lenses on Steinheil's principle, which are inexpensive and allow a large amount of light to pass. The lowest power usually made of those for microscopic dissecting purposes is admirable for lunar photography, and forms also a fine eye-piece for nebular and other work.

The camera is a very simple matter; a light tapering wooden tube with screw fitting to take the eye-piece tube, and plate-holder of the lightest form obtainable, being all that is required. A series of such tubes fitting the same plate-holder and ground-glass screen may be made at a small cost. The focussing screen should be finely ground, and in its centre a piece of thin microscopic glass should be cemented on the ground side by Canada balsam, thus making a space of clear glass through which the

aerial image may be focussed with a lens. A good lens for this purpose is an ordinary photographer's focussing lens or one of the cheap single lenses mounted in a short tube commonly sold for sixpence.

An instantaneous shutter is not essential, if exposures are long enough to be given by uncovering and covering the telescope tube by hand. A light cardboard disk with a few corks fastened to it, to rest over the mouth of the tube, answers for this purpose very well.

A shutter, however, working with very little vibration is a great advantage, and may be placed in the reflecting telescope within the main tube over the eye-piece fitting.

There is no necessity for a guiding telescope in lunar photography, the exposures being so short that the clock need only be regulated to as correct a rate as possible, and then left to do its work.

With regard to the most suitable dry plates, mere rapidity is not always advantageous. It may be necessary with a fixed instrument to use very rapid plates, but wherever possible slow plates of fine grain, with plenty of silver in them, should be chosen, as the amount of development they will stand greatly counterbalances their lack of speed. Much may be done by a patient worker in the dark-room with the good old pyro-soda developer; it is slow but sure, and gives great printing density. Metol is very rapid and useful in some cases where the light has been deficient.

Unless the telescope be of great size, the most valuable work will be done by confining one's attention to enlargements of the terminator with as long an exposure as may be managed. The light here is feeble and falls off more rapidly than visual observation would lead one to expect; but the relief of lunar objects is of the greatest importance, and a series of photographs of the terminator extending over a number of years is certain to prove of value. Enlarged photographs of regions under a high sun should also be tried, as photography affords a convenient method of recording surface shadings.

Unsteady air is the bugbear of the lunar photographer, and each worker will find a certain enlargement suitable for his telescope on average nights, which can only be exceeded with success on a few nights in the year.

A record should be kept of the conditions of light, air, aperture, enlargement, &c. under which every plate is exposed, for in this work, as in most branches of science, it is by our failures that we learn more than by our successes.

Published 18th January, 1902.

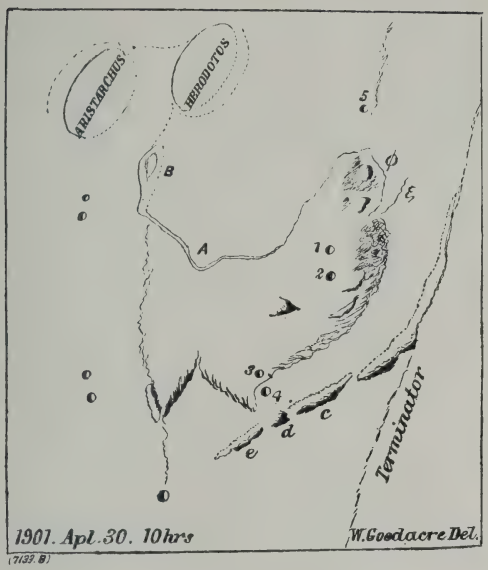


FIG. 1. ARISTARCHUS AND SCHRÖTER'S VALLEY.
By W. Goodacre, F.R.A.S.

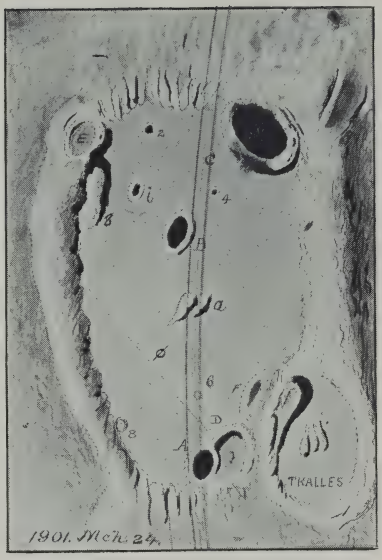


FIG. 2. CLEOMEDES.
By W. Goodacre, F.R.A.S.

FIG. 3. ENDYMION.
By Scriven Bolton.

FIG. 4. COPERNICUS
(1898, March 2).
By C. F. Smith.

FIG. 1. GRIMALDI
(1901, October 25).
By W. Goodacre, F.R.A.S.

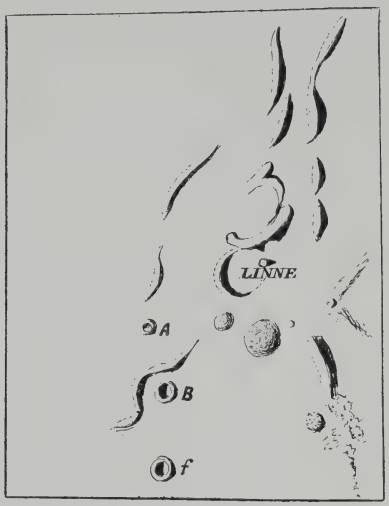


FIG. 2. LINNÉ
(1900, January 7, 6 h. 30 m. to 7 h.).
By Henry Corder.

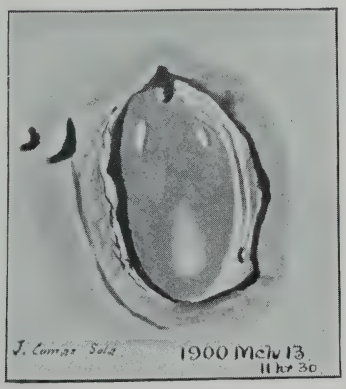


FIG. 3. BILLY.
By J. Comas Sola.

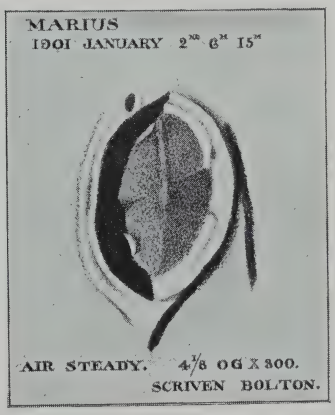
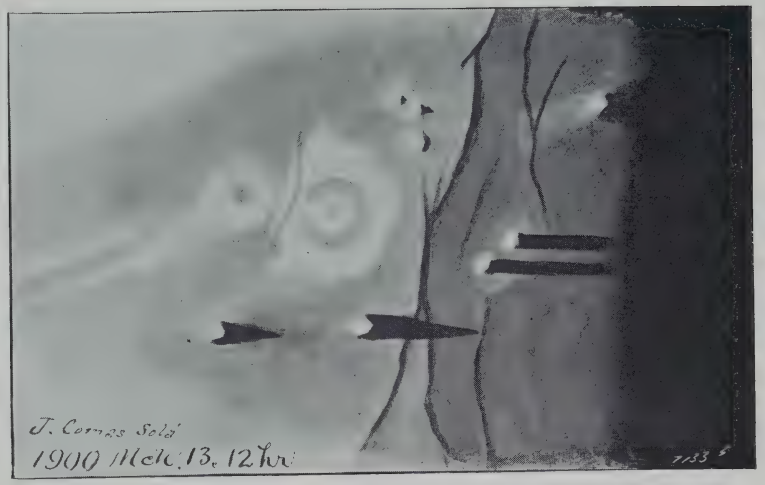


FIG. 4. MARIUS.
By Scriven Bolton.



REINER.
By J. Comas Sola.

Fig. 1. Doppelmayer
(1900, October 4, 8 h.).
By Scriven Bolton.

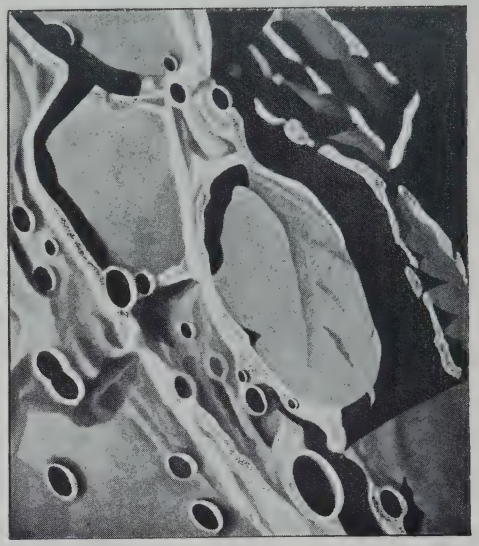


Fig. 2. Wargentin, etc.
(1900, September 6, 10 h. to 10 h. 45 m.).
By Scriven Bolton.

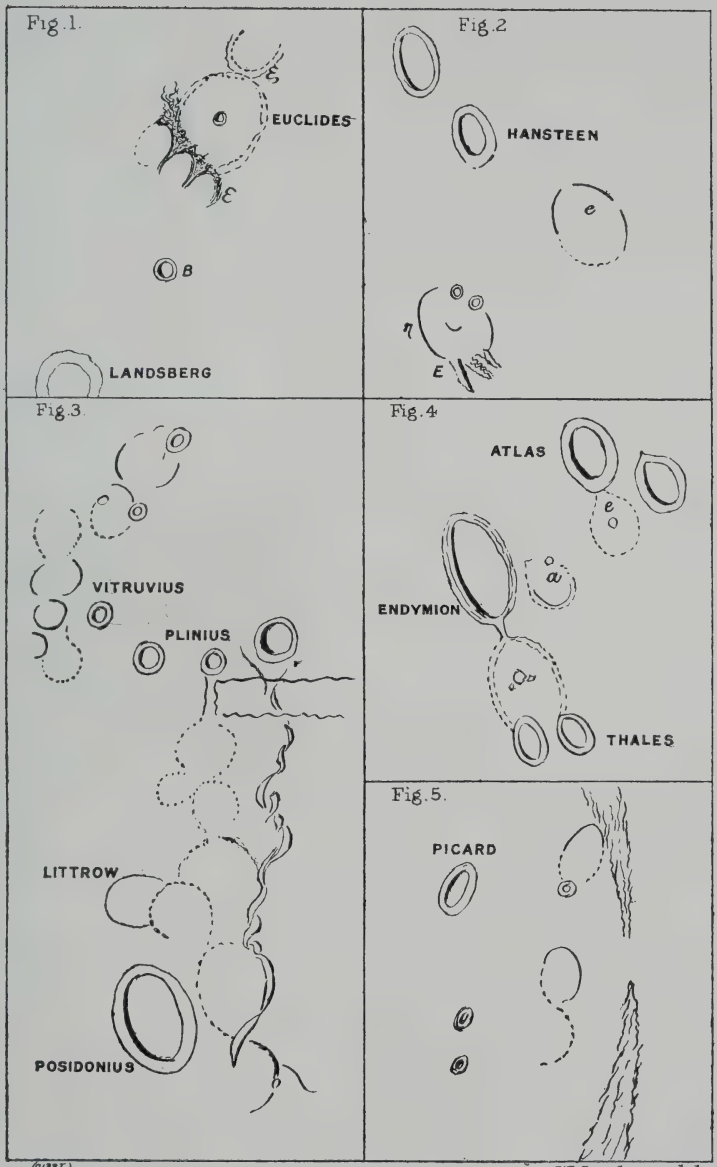


Fig.1.
EUCLIDES
B
LANDSBERG
Fig.2
HANSTEEN
e
η
E
Fig.3.
VITRUVIUS
PLINIUS
LITTROW
POSIDONIUS
Fig.4
ATLAS
e
a
ENDYMION
THALES
Fig.5.
PICARD
(7)391.)
W.Goodacre del

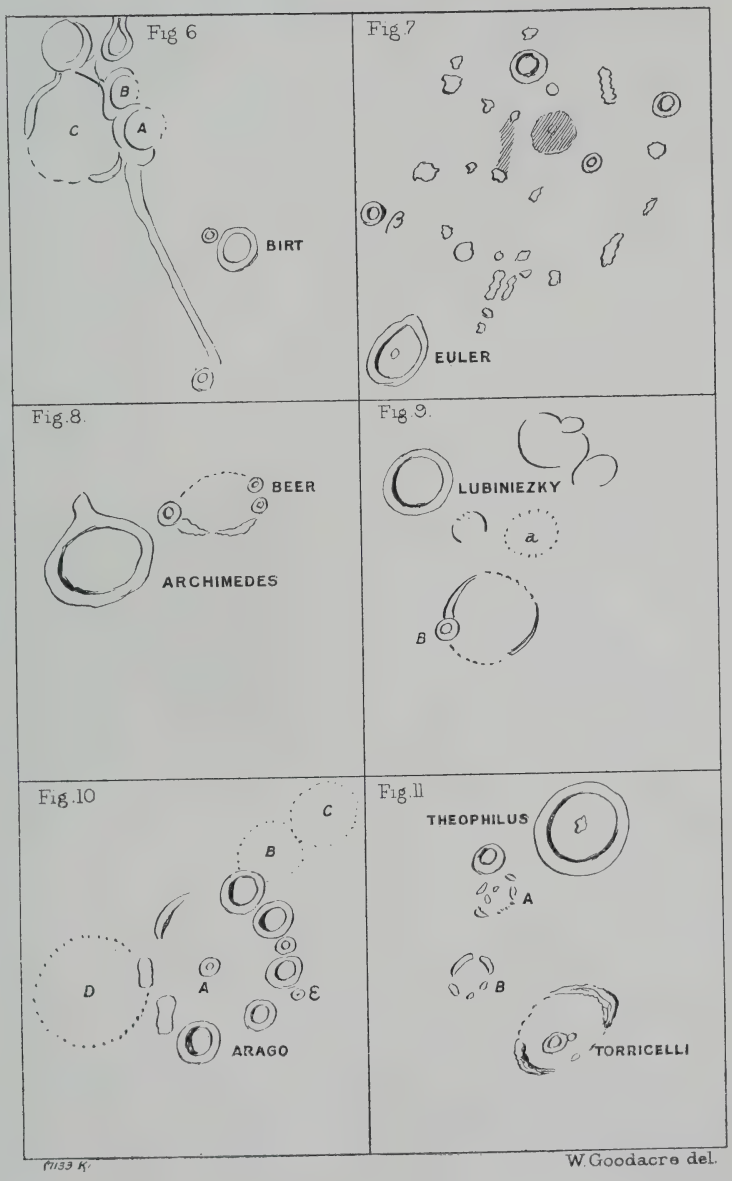


Fig 6
B
C
A
BIRT
Fig.7
β
EULER
Fig.8.
BEER
ARCHIMEDES
Fig 9.
LUBINIEZKY
a
B
Fig.10
C
B
D
A
ε
ARAGO
Fig.11
THEOPHILUS
A
B
TORRICELLI
W. Goodacre del.

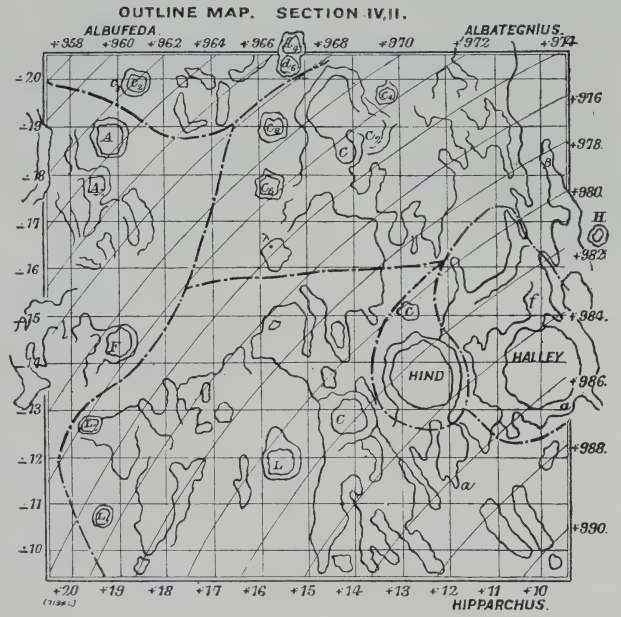

OUTLINE MAP. SECTION IV,II.
ALBUFEDA
ALBATEGNIUS.
HIND
HALLEY
HIPPARCHUS.

FIG. 1.

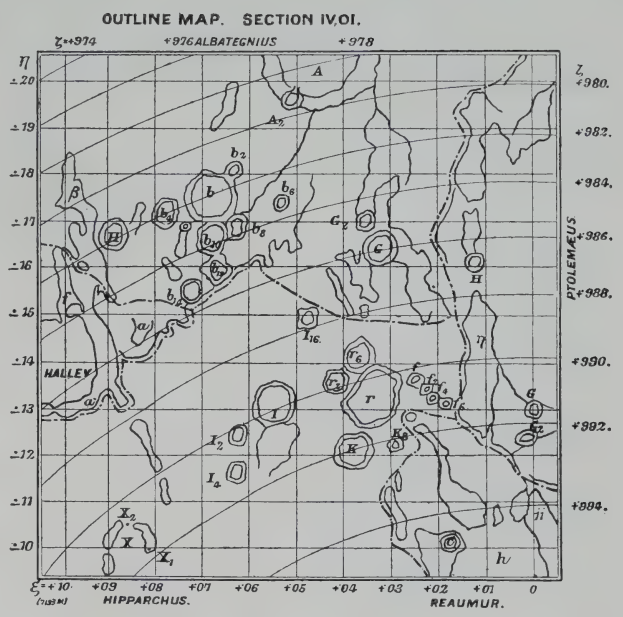

OUTLINE MAP. SECTION IV,OI.
ALBATEGNIUS
HALLEY
PTOLEMÆUS
HIPPARCHUS.
REAUMUR.

FIG. 2.

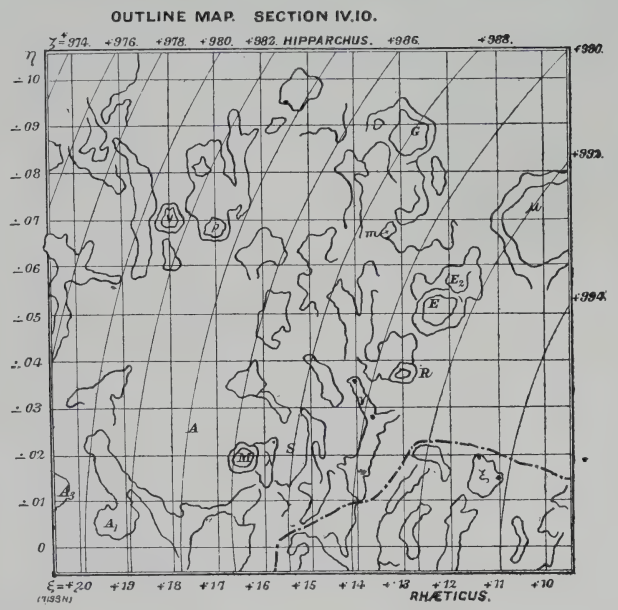


FIG. 1.

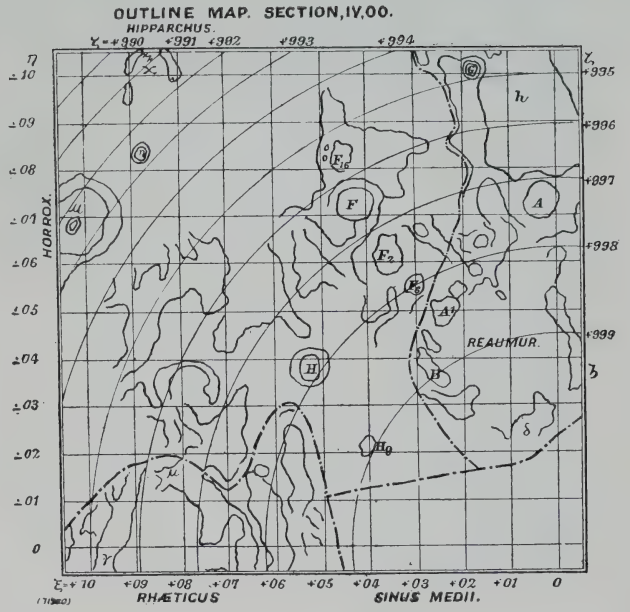


FIG. 2.

PLATE IX.

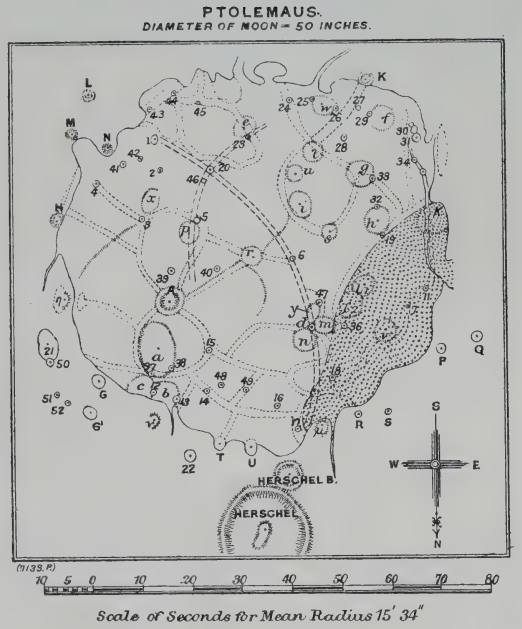


FIG. 1.

FIG. 2. THEOPHILUS
(1901, May 23, 8 h. 45 m.).
By Scriven Bolton.

PLATE X.

SECTION FOR THE OBSERVATION

OF

VARIABLE STARS.

DIRECTOR.—COL. E. E. MARKWICK, F.R.A.S.

Memoir of Nova Persei.

GENERAL REMARKS.

Since its first outburst, now at time of writing, considerably over 12 months ago, a wealth of scientific literature has appeared in connection with "Nova Persei, 1901," undoubtedly the most remarkable stellar object of modern times. To summarise the whole, or even a good part of such publications, would be quite beyond the scope of this Memoir. Let it be stated at once, then, that the results here detailed are, with the exception of the light-curve, based almost entirely on observations made by Members of the British Astronomical Association. Hence it represents largely the work of amateur astronomers, and cannot in any way claim to be exhaustive.

It deals generally with the period from the outburst of the star up to the end of 1901.

Nova Persei, 1901, as is well known, was discovered by Dr. T. D. Anderson, of Edinburgh, at $2^h\ 40^m$ a.m. on February 22, 1901. It was then rated about 2·7 mag., and was rapidly rising to its culminating point of brilliancy. This distinguished observer, who was also the discoverer of Nova (T) Aurigæ in 1892, and since then, of quite a host of minor "variables," has received the Jackson-Gwilt medal of the Royal Astronomical Society in recognition of his brilliant work in this field of astronomy.

On the evening of February 22, it was a most brilliant star, above magnitude 1·0, and consequently it was observed independently by several Members of our Association, amongst whom may be mentioned Mr Ivo F. H. C. Gregg, of St. Leonards; Mr. J. E. Gore, of Dublin; Rev. S. J. Johnson, of Melplash, Dorset, and Mr. W. B. Dodd, of Whitehaven. The last three notified the Director almost immediately, but it was through the means of a telegram sent off most promptly at $7^h\ 40^m$ p.m. on Feb. 22 by Mr. Gregg, that the Director was able to make some very satisfactory observations on the evening of the day of discovery.*

* "Journal," Vol XI., p. 194.

Not knowing but what this (Mr. Gregg's) was the first discovery, if the phrase may be allowed, the Director at once wired particulars of the observation to the Astronomer Royal, from whom the following letter was received a few days later:—

"Royal Observatory, Greenwich,
"London, S.E.,
"DEAR SIR, 1901, February 25.

"I beg to acknowledge the receipt of, and to thank you for, your telegram relative to Nova Persei. We at once telegraphed the particulars to the Centralstelle at Kiel. Unfortunately it has been cloudy here for the last four nights, so that we have not been able to observe the new star, though it was seen faintly through the clouds last night.

The new star was seen by Dr. Anderson, of Edinburgh, on Thursday night, February 21, and was then of 2·7 magnitude.

"Yours faithfully,
"(Signed) W. H. M. CHRISTIE,
"Col. E. E. Markwick. "Astronomer Royal."
"H.M. Gun Wharf,
"Devonport."

It is understood that the Director's telegram was the first intimation received at Greenwich of the new star.

The telegram of the Astronomer Royal to Kiel was published in **A.N.** 3689–91, as follows;—"Markwick, of Devonport, wires "has seen Nova Persei yesterday, magnitude 0·5 or 0·75. "Colour, bluish white. Spectrum, apparently continuous. "Independently discovered by Gregg. CHRISTIE."

No time was lost in announcing the new star to the local press, and the following letter appeared in the "Western Morning News," on Feb. 23.

"*A New Star.*

"SIR,

"I received a telegram this evening from Mr. Gregg, an amateur astronomer, announcing that he just seen a strange star 'left of Algol' at 6.40 p.m., and inquiring what it is. On looking at that part of the sky, which is very well known to all observers on account of the presence of Algol, the celebrated variable star, I at once saw a brilliant star, which at a glance I knew to be new.

"Observing it with the naked eye, it appeared white, and of a magnitude between the 1st and 2nd. It was plainly less bright than Capella, but brighter than Alpha Persei. The binocular did not reveal much more. A $2\frac{3}{4}$-in. telescope was then used, with various magnifying powers. Of course it appeared, like all stars, a mere luminous point, of a steely white hue, with tinge of blue; something the same colour as Sirius.

"The position of the star is in the constellation Perseus, R.A. $3^h\ 24^m$; N. Decl. $43\frac{1}{2}°$.

"This star is no doubt one of the brightest 'novæ' or temporary stars, which have burst out in the skies since 1572, when Tycho observed the celebrated new star in Cassiopeia. It will

be observed, doubtless, by every astronomer in the northern hemisphere with the most intense interest. I hope to furnish further particulars in a day or two, as to whether its brightness has increased or diminished. I may add that its light, examined in a pocket spectroscope, gave a continuous spectrum, without any bright lines which are generally seen in the spectrum of a new star. There was no star of the brightness of the Nova in the place on the 15th instant, so the star must have burst out and attained its present extraordinary brilliancy within the space of seven days.

" (Signed) E. E. MARKWICK,
" February 22. Colonel, F.R.A.S."

A copy of this number of the " Western Morning News," was at once posted to each working Member of the Variable Star Section. It is, I think, a subject of mutual congratulation that we, Members of the British Astronomical Association, "got on" to this star, a few hours only after discovery, without any extraneous information on the subject whatever.

We now know that the outburst must have been far more rapid than indicated above, as there is no trace of the star on Mr. A. S. Williams' photograph, taken on February 20, 11^h G.M.T., which photograph shows stars of 11^m to 12^m.

In London, generally, the night of February 22 and several subsequent nights appear to have been cloudy, so that many did not see the star until past its prime.

So much for the circumstances attending the early days of Nova Persei.

As soon after as possible circulars, giving a map of the vicinity of the Nova and magnitudes of convenient comparison stars, were despatched to Members of the Variable Star Section, and others who were interested in the matter. Later on, a map of all the faint stars in the immediate vicinity of the Nova, based on Mr. Bellamy's paper in " Monthly Notices," Vol. LXI., p. 340, was prepared and issued.

SOME POPULAR VIEWS.

The social aspect of the outburst may be briefly touched upon here. The collision theory naturally lends itself to the popular imagination as one suiting the case. Hence we read in an article headed " A Crash in the Æther " (by A. Banker), " So far as we can judge with our imperfect instruments, thousands of billions of miles away, far in the deep abyss of eternal space, two mighty suns, careering through the interstellar void at the rate of hundreds of miles a second, met in mid-heaven with appalling crash, raising a fiery conflagration, so brilliant and dazzling that the glowing emerald-hued blaze was more radiant and intense even than mighty blood-red Aldebaran. Even the wildest flight of our imagination must fail to realize the dread awe and terror of this stupendous holocaust of worlds. For, not only the two gigantic suns, but also their attendant planets, each with circling satellites, must also have been involved in the

common ruin; some plunging headlong into the million-miled roaring furnace; some colliding with each other with tremendous impact, their crusts shattered and molten, and their released internal fires madly belching forth in coruscating tongues of flame; while perhaps others, driven off at a tangent by the titanic concussion, left their parent sun as dead worlds, and bounded off into the æther, there aimlessly to wander in blighting cold and darkness."

The writer then goes on to suggest that those inhabitants of the unfortunate planets concerned who "had not, by their mis-"deeds, caused their guardian angel to desert them, were caught "up and rescued from the impending judgment, and were allowed "to witness the dread scene safe from harm."

A beautiful, if somewhat fanciful, idea is contained in the following circumstance. It is stated, that when the news of the death of our late revered Queen reached South Africa in January 1901, a Kaffir Chief said "there will be a new star in the fir-"mament."

MAPS.

Two maps accompany this Memoir and will be found on pages 85, 86. The first shows the vicinity of the Nova, and is suitable for use with the opera-glass. The positions of the stars have been carefully checked, the numbers attached being those in the corresponding zone of the Durchmusterung.

The position of Nova Persei for 1900·0, as given by Mr. Bellamy in "Monthly Notices" R.A.S., Vol. LXI., p. 477, is

R.A. $3^h\ 24^m\ 24^s$; Dec. $+43°\ 33'\ 42''$

or, as it may be written, with quite sufficient accuracy for variable star observers,

R.A. $3^h\ 24^m{\cdot}4$; Dec. $+43°\ 33'{\cdot}7$

The other map, constructed on a larger scale, gives the field of view (inverted) in, say, a 3-in. refractor, low power. The diameter of the inner circle represents 1°. The connection between these two is easily ascertained by referring to the three stars, Nova, D.M. + 43° 732, and D.M. + 43° 730, which are common to the two maps. The neat triangle consisting of the three stars 730, 728, and 729 is a useful "land-mark," being a little outside the field of view, N.P. the Nova. It was thought best not to encumber the map with any fainter stars; those who are working at the subject can easily insert them from the telescope, if higher optical power is used.

Most, if not all, of the stars shown in the maps can easily be traced in Plate I. (Photograph of the vicinity, which is referred to further on), observing that this is a direct view, the same as the first map.

We now proceed to

THE OBSERVATIONS.

The daily means only of the observations of Nova Persei which have been forwarded to the Director are printed in the list at the end of this Memoir, which pretty well explains itself. The bulk of the work of the observers was the determination of brightness; but notes on colour, and general appearance of the star, as well as certain

spectroscopic results, were also received. These latter are dealt with under their respective heads. I believe that, with the exception of a few observations made by Miss Lucy Foster (since elected a Member) and communicated by Mr. Whitmell, they are entirely by Members of the B.A.A.

The following is a list of those who contributed observations. Where an abbreviation of the name is adopted in the list of observations, it is indicated in brackets after the name. An asterisk denotes a working Member of the Variable Star Section. It is assumed that all had a binocular of some sort in use, in addition to the instruments named :—

Observer.	Locality.	Instrument.
ANTONIADI, E. M., F.R.A.S.	Juvisy, France	10½-in. O.G. 6½ in. spec.
ASTBURY, T. H. (Ast.)	Wallingford.	—
BACKHOUSE, T. W., F.R.A.S.	Sunderland.	—
*BESLEY, W. E., F.R.A.S. (Be.)	Clapham	1⅝-in. O.G.
BOLTON, SCRIVEN	Leeds	4⅛-in. O.G.
BROOK, C. L., M.A., F.R.A.S., &c.	Meltham, Huddersfield.	—
*CHILD, J. W. L., F.R.A.S. (Ch.)	Wimbledon	8½ in. spec. 2-in. O.G.
CROMMELIN, A. C. D., F.R.A.S	Blackheath.	—
DODD, W. B.	Whitehaven.	—
DOWNING, A. M. W., M.A., D.Sc., F.R.S., F.R.A.S.	Blackheath.	—
FREEMAN, A.	Hastings	4-in. spec.
GOODACRE, W., F.R.A.S.	Crouch End, N.	—
GORE, J. E., M.R.I.A., F.R.A.S.	Dublin	3-in. O.G.
GROVER, C.	Rousdon, Dorset	6·4 in. O.G.
GREGG, I. F. H. C.	Bournemouth.	—
HOLMES, E.	Hornsey	12¼-in. spec.
KEIR, S. C.	Lancaster.	—
KELLY, J. (Ke.), Brigade-Surgeon	Kingstown, co. Dublin.	3-in. O.G.
KILLIP, Rev. R., F.R.A.S.	Liverpool	5-in. O.G.
*KING, A. (Ki.)	Leicester	2⅛ in. O.G.
*LE BEAU, O. A. (LeB.)	Bedford and Edinburgh.	2-in. O.G. 1-in. O.G.
MACLACHLAN, N.	Largs, N.B.	2¼-in. O.G.
*MARKWICK, Colonel E. E., F.R.A.S. (Ma.)	Devonport	2¾-in. O.G.
MIDDLETON, G. W. (a former working Member) (Mi.)	Mexborough	2¼-in. O.G.
MOYE, M., D. en D.	Montpelier, France.	—
*ORR, Miss M. A. (Or.)	Frimley, Surrey	3-in. O.G.
*PERIDIER, J. M. (Pe.)	Paris, France	5¼-in. spec. 1¾-in. O.G.
RALMORE, T.	Southsea	3⅖-in. O.G.
RYVES, P. M.	Topsham	3-in. and 1⅝-in. O.G.
SHARP, M. C., M.A., F.R.A.S.	Highgate, N.	2½-in. O.G.
TOMKINS, H. G.	Allahabad, India	9-in. spec.
WAUGH, Rev. W. R., F.R.A.S.	Portland.	—
WHITMELL, C. T., M.A., F.R.A.S., &c.	Leeds.	—
WOOD, J. T.	Nottingham.	—
*WORSSELL, W. M. (Wl.)	Arundel, but now Krugersdorp, S.A.	—

The figures in column headed "class" are not to be taken in quite the same sense as "weight"; they are intended to represent the amount of hindrance to the observation concerned, such as clouds, haze, moonlight, twilight, &c. Thus 1 indicates a good sky; 2, one with more or less cloud, moonlight, &c.; 3, very bad sky, much obscured, &c. Equal weight has been given to all the observations alike, as, although some of the observers were inexperienced and their results wild, yet it is thought these balance one another pretty well on the whole. When no particulars of sky, &c. were given in the original record, a dash only is inserted. All observations whatsoever in June and July are classed 2 on account of the difficult conditions of observing which prevailed in those months, owing to twilight and the low altitude of the star.

Where possible, the brightness of the star has been deduced on the scale of the "Revised Harvard Photometry" (or the "Photometric Durchmusterung," for some fainter stars). The greater part of the observations are differential; there are some few in which the estimates of brightness are intrinsic. The second decimal must be taken only for what it is worth, that is, little or nothing. It comes out from the R.H.P. Scale, which gives two decimals in the comparison stars' magnitudes.

The two following stars which have certain fainter stars clustering near them, thus enhancing their brightness when seen in the binocular, which does not, through lack of magnifying power, discriminate the fainter companions, have been rated as shown, when used with that instrument:—

D.M. + 44° 734 $6^m \cdot 0$.
„ + 43° 730 $6^m \cdot 8$.

These are the only alterations to the magnitudes of the comparison stars, as given in the above-mentioned Catalogues.

Each observer's "step" has been taken as $0 \cdot 1$ mag. Doubtless some, if not all, observers' "steps" differ from this; but it is doubtful if any increase in accuracy would be obtained by making any alteration to the deduced magnitudes on this account.

It may be remarked here that the relative photometric magnitudes of stars do not always coincide with the visual. Thus, several observers note that σ Persei ($4^m \cdot 50$ R.H.P.), is distinctly brighter that ψ Persei ($4^m \cdot 22$). Also two observers of experience find 32 Persei ($5^m \cdot 13$), half a mag. above 30 Persei ($5^m \cdot 37$).

Mr. Astbury thinks that star DM. + 43° 732 has varied considerably while he was watching the Nova.

The observations number in all 1160. From February 22 to December 31 there are 313 days. Observations of the star were made by some one or other on 247 days, leaving 66 days on which we have no (B.A.A.) record of the star's brightness.

At the end of the observations for each day was inserted the arithmetical mean of all for the day, and this alone has been printed. These "means" have been plotted on squared paper, and the points joined. The result (not published) is a zigzag line which agrees substantially with the light-curve (Plates II., III., and IV.). Mr. J. W. L. Child kindly prepared for the press the fair copy of the list of observations.

Brightness of Nova Persei.

1901 FEBRUARY 22 TO DECEMBER 30.

(Daily Means.)

Date.	Number of Observations.	Mean Magnitude.	Remarks by different Observers.
1901.			
Feb. 22	5	0·87	White; white with tinge of blue.
,, 23	4	0·41	V. white; a colder white tint than Capella.
,, 24	5	0·24	V. white; white with tinge of yellow. Pale yellow.
,, 25	12	0·84	White; bluish white; greenish white; similar in colour to Pollux (*i.e.*, yellow).
,, 26	13	1·01	White; white with tinge of yellow, like Pollux. Pale or., slightly ruddy.
,, 27	9	1·38	Or. yellow; red.
,, 28	21	1·58	Or. yellow; pale or.; slightly ruddy; quite ruddy.
Mar. 1	24	2·02	Silvery; pale yellow; or. yellow; red; decidedly ruddy.
,, 2	15	2·08	Red; decidedly ruddy.
,, 3	31	2·37	Whitish; pale yellow; various combinations of or., yellow, and red.
,, 4	—	—	No observations on this date.
,, 5	18	2·49	Or.; yellow; red.
,, 6	16	2·97	Or.; red.
,, 7	16	2·90	Crocus yellow; claret red, &c.
,, 8	13	3·05	Yellow; ruddy; or.-red.
,, 9	10	3·44	Or.; red.
,, 10	11	3·27	V. red; orange to naked eye.
,, 11	6	3·51	Warm yellow.
,, 12	11	3·43	Or.; v. red; redder than Mars.
,, 13	4	3·75	V. red.
,, 14	6	3·39	A little less red.
,, 15	1	3·60	
,, 16	12	4·02	V. ruddy; deep crimson red.
,, 17	3	4·00	Or.
,, 18	12	3·82	Or.; pale yellow; v. red.
,, 19	3	5·16	
,, 20	8	3·73	Slightly less orange.
,, 21	15	3·96	V. red. In Tel. fiery red.
,, 22	9	4·59	Or.; very blue (!).
,, 23	7	3·91	Red; blue (!).
,, 24	12	4·14	Not so red as before. Flame colour.
,, 25	17	5·16	V. red. Warm ruby tint.
,, 26	17	4·26	Or.; red.
,, 27	17	4·07	Or.; pale or.
,, 28	17	4·89	Yellowish red; red.
,, 29	4	4·57	
,, 30	11	4·10	Or.; yellow; warm red.
,, 31	16	4·29	

Date.	Number of Observations.	Mean Magnitude.	Remarks by different Observers.
1901.			
Apr. 1	22	4·24	Or.; red; yellowish red.
,, 2	1	5·50	
,, 4	15	4·16	Or.; paler; deep crimson has gone.
,, 5	13	4·43	Red; yellowish red.
,, 6	3	5·20	
,, 7	6	5·44	Pale red.
,, 8	8	4·42	Redder.
,, 9	10	4·61	Reddish.
,, 10	13	5·30	V. red; flashing crimson.
,, 11	7	5·21	Brilliant red.
,, 12	12	4·79	Pale or.
,, 13	12	4·35	Redder.
,, 14	13	5·31	
,, 15	10	5·50	Yellow or.
,, 16	11	5·42	Or.
,, 17	8	5·05	Or.
,, 18	15	4·23	Paler.
,, 19	17	5·32	
,, 20	20	5·50	Or. red. Still ruddy.
,, 21	17	5·51	
,, 22	9	5·42	Red.
,, 23	16	4·16	Or.; or.-yellow. Distinctly flashing white in binocular.
,, 24	6	5·31	
,, 25	13	5·62	Red.
,, 26	9	5·54	Red.
,, 27	7	4·36	Or.
,, 28	4	5·25	
,, 29	1	5·0±	
,, 30	3	5·49	
May 1	2	4·53	
,, 2	1	4·36	
,, 3	3	6·04	Colour uncertain.
,, 4	5	5·81	Red.
,, 5	3	5·60	Red-or.
,, 6	4	5·67	
,, 7	3	4·90	Less red than on 4th.
,, 8	2	5·11	
,, 11	2	5·76	
,, 12	3	5·52	
,, 13	6	5·11	
,, 14	5	5·56	
,, 15	4	5·78	
,, 16	3	5·80	
,, 20	4	6·07	
,, 21	1	6·00	
,, 22	4	5·34	
,, 23	2	6·20	
,, 24	2	6·12	
,, 27	1	6·00	
,, 31	1	5·80	
June 6	1	6·10	
,, 8	1	<5	
,, 9	2	5·37	Yellow-or.
,, 10	1	—	do.
,, 17	2	6·06	

Date.	Number of Observations.	Mean Magnitude.	Remarks by different Observers.
1901.			
June 18	1	6·10	
,, 21	1	6·02	
,, 23	4	5·77	
,, 24	1	5·20	
,, 25	1	5·65	?
,, 27	4	5·69	
,, 28	1	6·10	
July 3	1	6·20	
,, 6	1	5 88	
,, 7	2	5·65	
,, 8	1	5 68	
,, 9	1	5·70	
,, 10	1	6·00	
,, 11	2	5·85	
,, 12	1	6·00	
,, 13	3	5·87	
,, 14	1	5·80	White : no red tinge.
,, 15	5	5·66	
,, 16	3	5·78	
,, 17	3	5·95	
,, 18	4	5·75	
,, 19	3	5·81	
,, 20	3	5·63	
,, 21	1	5·90	
,, 22	1	5·90	
,, 23	1	5·80	
,, 24	3	6·02	
,, 26	2	6·50	Yellow.
,, 27	2	5·84	
,, 28	1	5·70	
,, 30	1	6·50	
,, 31	3	5·88	
Aug. 2	2	5·92	
,, 3	1	6·00	
,, 4	2	5·97	
,, 6	4	5·73	
,, 7	2	5·57	
,, 8	6	5·92	
,, 9	3	5·97	
,, 10	4	5·80	
,, 11	2	5·85	
,, 12	3	5·65	
,, 13	2	6·22	
,, 14	2	6·05	
,, 15	6	5·88	
,, 17	4	5·83	
,, 18	5	5·99	
,, 19	4	5·98	
,, 20	9	5·93	White ; and v. white.
,, 21	5	5·95	
,, 22	5	5·93	
,, 23	1	5·93	
,, 24	4	6·01	
,, 25	2	5·86	
,, 26	2	5·86	
,, 27	4	5·86	

Date.	Number of Observations.	Mean Magnitude.	Remarks by different Observers.
1901.			
Aug. 28	2	5·90	
„ 30	1	6·10	
„ 31	1	5·90	
Sept. 1	1	5·98	
„ 2	1	6·58	
„ 3	3	6·01	
„ 4	3	5·94	
„ 5	3	5·99	
„ 6	1	5·85	
„ 7	2	6·27	
„ 8	2	6·26	
„ 9	3	6·23	
„ 10	2	5·97	
„ 11	1	6·00	
„ 12	1	6·00	
„ 13	2	6·47	
„ 14	5	6·01	
„ 15	6	6·14	
„ 16	4	5·96	
„ 17	2	5·95	
„ 18	3	6·07	
„ 19	1	6·45	
„ 20	2	6·02	
„ 21	2	6·07	
„ 23	4	6·04	
„ 24	4	6·05	
„ 26	2	6·15	
„ 27	1	6·10	
„ 29	1	6·10	
Oct. 2	4	6·02	
„ 3	2	6·42	
„ 4	5	6·22	
„ 5	7	6·17	
„ 6	3	6·09	
„ 7	3	6·68	
„ 8	1	6·41	
„ 9	5	6·39	
„ 10	2	6·77	
„ 11	2	6·40	
„ 12	1	6·68	
„ 13	2	6·68	White
„ 14	1	6·00	
„ 15	1	6·25	
„ 16	2	6·41	
„ 17	1	6·32	
„ 18	4	6·41	
„ 19	4	6·57	
„ 20	1	6·71	
„ 21	1	6·25	
„ 22	1	6·20	
„ 24	2	6·70	
„ 26	1	6·20	
„ 29	1	6·25	
„ 30	1	7·30	
„ 31	6	6·71	

Date.	Number of Observations.	Mean Magnitude.	Remarks by different Observers.
1901.			
Nov. 2	1	7·10	
„ 3	1	6·51	
„ 4	2	6·67	
„ 7	1	6·35	
„ 9	1	6·60	
„ 10	1	6 70	
„ 11	2	6·70	
„ 13	1	7·07	
„ 14	4	6 66	
„ 15	3	6·75	
„ 16	3	6·79	
„ 17	2	6·71	
„ 19	1	6·50	
„ 20	2	6·60	
„ 21	3	6·79	
„ 23	2	6·93	
„ 25	1	7·08	
„ 28	2	6·80	
„ 29	2	6·79	
„ 30	2	6·77	
Dec. 1	1	6·60	
„ 2	2	6 90	
„ 3	2	6·70	
„ 4	3	6·77	
„ 5	3	6·74	
„ 6	2	6·60	
„ 7	1	6 70	
„ 8	2	7·12	
„ 9	1	7·17	
„ 10	5	6·88	
„ 11	3	6·90	
„ 12	1	7·07	
„ 13	1	6·60	
„ 14	2	6·60	
„ 15	1	6 50	
„ 16	2	7·31	
„ 17	1	6·85	
„ 18	4	6·82	
„ 19	1	6·90	
„ 20	1	6·93	
„ 26	1	7·03	
„ 27	2	7·47	
„ 29	2	7·12	
„ 30	1	7·21	

LIGHT CURVE.

Plates II., III., and IV. are reproduced from a drawing very finely and carefully executed by Mr. J. E. Gore, M.R.I.A., F.R.A.S., specially for this Memoir. The curve, as delineated, is based on over 1,100 observations, viz., those detailed in this Memoir, and others made in America, all reduced to the R.H.P. scale of magnitudes. The curve may therefore be called an "Anglo-Saxon" one. The ratio of magnitude to time, *i.e.*, ordinate to abscissa is—

1 mag. (ordinate) = 20 hours (abscissa).

This scale opens out the curve more widely than is usually the case in diagrams giving changes of variable stars, and thus renders any small variations more easily visible. The length of the curve in the original drawing is about 20 feet; it refers to the period February 22–August 31.

The American observations, being from 5 hours to 8 hours later than those made in this country, have proved very useful in establishing the curve at the times in question, *i.e.*, they fill up gaps beautifully. Mr. Gore remarks it is a pity we have not some good observations from India and China.

Some of the observations about February 25–28, it will be noted, are rather discordant, differing as much as a whole magnitude, *inter se*, on some occasions.

The brilliancy of the star at the time is probably the reason for this, it being notoriously difficult to estimate the brightness of a star when near the 1st mag. Probably from date of maximum to February 27 the observations may be represented by a straight, or nearly straight, line.

The principal critical points in this curve are indicated in the following table:—

Date.	Mag.	Points.	Remarks.
1901.			
Feb. 23·46	0·1	Great maximum.	Probably correct to within 6 hours either way.
„ 27·25	—	—	Slight undulations of about 1 day's duration commence.
Mar. 11 to 13	—	—	One or two undulations, $\frac{1}{2}$ mag.
„ 18	—	—	Well marked fluctuations commence here.
„ 19·33	5·2	Minimum	
„ 20·6	3·45	Maximum	
„ 22·1	5·5	Minimum	Rapid fall and rise.
„ 23·5	3·9	Maximum	Curve flat. Time doubtful.
„ 25·5	5·25	Minimum	Well marked.
„ 26·7	3·7	Maximum	
„ 29·0	4·8	Minimum	
„ 30·6	4·1	Maximum	A sort of double maximum.
Apr. 1·25	4·2	2nd Maximum.	A sort of double maximum.
„ 2·9	5·5	Minimum	
„ 4·66	4·1	Maximum	
„ 7·0	5·5	Minimum	
„ 8·8	4·1	Maximum	
„ 11·0	5·5	Minimum	

Date.	Mag.	Points.	Remarks.
1901.			
Apr. 13·0 -	4·2	Maximum	
„ 15·4 -	5·6	Minimum	
„ 18·25 -	4·2	Maximum	
„ 19·5 to 22·0	—	? Minimum	Curve flat. Date of minimum uncertain.
„ 23·25 -	4·2	Maximum	Well indicated. The type of pointed maxima and flat minima now commences.
„ 26·0± -	5·7	Minimum	Not well indicated. Curve flat.
„ 27·6 -	4·2	Maximum	Clearly shown.
„ 29·25 -	5·6	Minimum	Curve flat.
May 2·5 -	4·4	Maximum	Sharp.
„ 4·25 -	6·0	Minimum	Curve flat.
„ 7·6€ -	4·3	Maximum	Sharp.
„ 10·17 -	6·0	Minimum	Flat.
„ 13 17 -	5·0	Maximum	Flat. Different type.
„ 15·75 -	6·0	Minimum	Flat.
„ 18·17 -	4·6	Maximum	Doubtful. Observations scarce.
„ 21·4 -	6·2	Minimum	
„ 22·5 -	4·7	Maximum	Sharply defined.
„ 24·0 -	6·2	Minimum	The curve keeps pretty steady at this for a time; but observations are very few.
June 3·75 -	4·9	Maximum	
„ 8·4 -	4·6	„	Apparently sharp. After this no very marked features.
„ 24·5 -	5·2	„	A low maximum.
July 13 -	—	—	Small undulations, nearly synchronising with 1 day in duration, commence here.
„ 16·83 -	6·5	Minimum	
„ 17·4 -	6·2	Maximum	
„ 17·9 -	6·7	Minimum	
„ 18·5 -	6·0	Maximum	
„ 18·8 -	6·5	Minimum	
„ 22·8 -	6·5	„	
„ 23·4 -	5·9	Maximum	
„ 23·8 -	6 6	Minimum	
„ 24·5 -	6·2	Maximum	
„ 27·6 -	6·0	„	
„ 28·1 -	6·8	Minimum	From this point onwards to the end of August the curve keeps very flat.

This curve is supported in all important particulars by the chart of variation published by F. Hagen in "Supplementary Notes to the Atlas Stellarum Variabilium," and by a curve drawn by Mr. J. W. L. Child and published in "Monthly Notices," Royal Astronomical Society, Vol. LXI., No. 7. The agreement with the latter as to dates of maxima and minima is practically exact.

It is right to observe here, however, that the unfavourable conditions for observation prevailing in the months of June and July may possibly have masked some fluctuations not recorded.

From September 1 to the end of the year the star declined pretty steadily till it was 7·2 mag. on December 30. From an inspection of the plotted "means" of our observations, referred to

under that head, the following seem to be the dates of the chief fluctuations, although it should be observed that they are comparatively small in extent, and a smooth "curve" drawn "through" the points would result in a more or less straight line, sloping gradually downwards from 6·0 on September 1 to 7·2 December 30. The "Maxima" and "Minima" here referred to are in an entirely different category from those well marked and definite ones occurring earlier in the star's history.

Maxima.		Minima.	
Date.	Mag.	Date.	Mag.
Sept. 6	5·8	Sept. 2	6·6
„ 10	6·0	„ 8	6·25
Oct. 6	6·1	„ 13	6·5
„ 14	6·0	„ 19	6·45
„ 22	6·2	Oct. 3	6·4
„ 26	6·2	„ 7	6·7
Nov. 7	6·3	„ 10	6·8
„ 19	6·5	„ 20	6·7
Dec. 15	6·5	„ 24	6·7
		„ 30	7·3
		Nov. 13	7·1
		„ 25	7·1
		Dec. 16	7·3
		„ 27	7·5

It is possible that a few of the above maxima and minima may be more or less fictitious, as observations for this period are few in number compared with March and April, and some depend on an observation by a single observer.

During the year 1902 up to the time of writing the star seems to have been steadily and gradually fading.

It might have been thought that with such comparatively rapid variation as occurred in the star's light, especially during the period commencing March 18, the change of light would have been rendered visible by the English observations of a single evening, extending, perhaps, as they may do, over three hours or more. But it is only in a few cases, where a definite change of light could be inferred from the observations of one evening taken alone. The observations seem to cluster very often with the longer axis of the cluster vertical and *perpendicular* to the light curve, or else inclined considerably to it. Take April 5, 16, 20, 21, &c., as illustrating this.

This is due, no doubt, in whole or part, to the following causes:—1. Many of the observers being inexperienced and their results "wild." 2. Their not adopting a uniform light scale, and 3. Variation of light not sufficiently rapid to be definitely detected in a very few hours. We often find a similar "scattering" of observations (although not so marked) in the regular work of the V.S.S., where all the observers are more or less practised hands, and all the observations are reduced to the same scale.

That our observers are not peculiar in this, is at once made clear by a reference to the "Monthly Notices," Royal Astronomical

Society, Vol. LXI., where we find the following determinations of magnitude recorded on the days named.

Date.	Radcliffe Observations, Oxford (p. 545).	Mr. A. S. Williams (p. 551).
May 12	5·20	6·3.
„ 13	4·50	5·4.
„ 18	4·65	5·8 and 5·9 (mean 5.85).
„ 22	4·40	5·45 and 4·9 (mean 5·0 and 5·2 5·14).

Here are differences in two cases of over 1 mag. in the deduced brightness! The Director's attention was called to this by Mr. Brook.

Mr. Brook was, I think, most successful in detecting the change of light in one evening. On April 19 he observed at intervals over a period of $3^h\ 45^m$. His determinations of light were—

	h	m	m
At	9	15	5·15
	10	0	5·27
	11	0	5·37
	12	0	5·37
	13	0	5·48

These observations indicate a fading by 0·33 mag., and are generally supported by the light curve. Yet from *all* the observations on this evening taken together, it is difficult or impossible to deduce any change.

When, however, we bring in the American observations made, say, five to eight hours later than ours, there are cases where the daily variation is clearly indicated; *e.g.*, it was rising on March 20, 22, and 26, and falling on March 21, April 13.

Any early morning observations made in England would have been invaluable; and it was remarked by a Member of the Association, that glory awaited the energetic observer who would devote a whole night to observations. Yet, after all, this would have been almost impracticable as the star in the early hours, must, about March or April, have been low down on the northern horizon and immersed in its fogs and haze.

Mr. Astbury notes that from his observations alone the curve in March was rounded at maxima and sharp at minima; while in April these conditions were reversed. This is apparent from our curve.

Dr. Kelly calls attention to the great variation on March 22; it ranged through a whole magnitude in three hours or so, which can also be seen in Plate II.

Other observers were, at the time, aware of the fluctuations of light which were taking place during this "variation season" of the star, as it may be termed. Thus, Mr. Freeman calls attention to a rise of $1\frac{1}{2}$ mags. in 24 hours, April 22–23; a fall of over 2 mags. in the 48 hours, April 23–25, and a fall of 2 mags. in six days about May 3. Also Mr. Gregg noticed the sudden rise of 2 mags. during April 15–18. These estimates, while giving the character of the variation correctly, err a little in excess, as regards its amount.

COLOUR, &c.

All the remarks of observers on the colour of the star are included in the table of observations. The star at its first appearance was white, with tinge of blue, after the tint of Sirius. On the next day, February 23, it was still a cold white. The Rev. S. J. Johnson, a veteran observer, saw it then similar to Rigel in colour. But on February 24, the first note of change, although small, already appears in the term "pale yellow." Up to February 26 it was to most eyes white, with a tendency to yellow. The change from white round through yellow seems to have been rapid, and to have commenced about February 25–26, if indeed the change in tint was not continuous from the very first; Mr. Brook on February 25 made it whiter than Capella.

On February 27 comes another change in such remarks as "rather red" and "slight rose tinge." After this, it is either orange or red, and so continues for a considerable time, but with certain fluctuations withal, the extreme redness being, perhaps, associated with maxima. Thus, on March 23, when the star was at a maximum, it was noted as "redder"; but next day getting fainter, the redness was not so noticeable. Again, on April 1 (max.), it was "deep crimson." However, on April 4 (max.) the deep crimson colour had left it. On April 8 (max.) it was noted as redder, and so on.

Mr. Astbury, who gave special attention to colour, points out that during the great fluctuations, March 18–31, each increase of brightness was accompanied by a corresponding increase in redness.

The paper in the "Monthly Notices" by Mr. Child, previously alluded to, clearly brings this out in tabular form. Thus all maxima are described as "red" or "very red," while at 3 minima the star was "orange."

The wonderful redness of the star on March 26, when it was at or near a maximum, was also noted by Mr. Lewis, of the Royal Observatory, Greenwich.

Mr. Maclachlan remarks that on March 3 the most noticeable feature of the Nova was its dulness, the disc appearing scarcely any brighter than that of Mars, with which he compared it; but it showed considerable red prismatic colouring in the flare on the upper side as seen in a $2\frac{1}{4}$-in. refractor. The diffraction rings were much less marked and distinct than those of α and β Persei. On March 5 this observer reports that the red colour of the Nova was much more striking in a 5-in. refractor. With elongated focus the centre of the misfocussed image was deep blood red crimson; Algol with the same elongated focus was also red, but the red was much paler; ϵ and δ Persei showed only a faint purple centre with the same focus. With the sharpest focus the disc of the Nova was not so clean as in the case of β, δ, and ϵ, and showed a tendency to a brighter red undefined edging around its limb, almost amounting to a blurring of the limb. Its diffraction rings, too, were blurred, although in the comparison stars the rings were quite clear and distinct.

These observations are interesting in view of what we now know about the 'aureola' and the nebula surrounding the star, and show that there was then a peculiarity in the star's light. [*See* a

brief abstract of Mr. Maclachlan's thoughtful paper in "Journal," Vol. XI., p. 259.]

It has been attempted in fig. 3 (p. 86) to render visible to the eye the changes in colour during a portion of the star's career. On the left hand side is a small representation of a spectrum placed vertically with the red end upward, and divided into compartments representing roughly the principal tints. A dot represents a colour determination, its position as regards vertical distance above the line AB being fixed by the nature of the colour, while the time is represented horizontally in the usual way by the scale indicated. Owing to diversity of descriptions and idiosyncracies of observers, it is difficult sometimes to say what particular tint the star was on a given day. One could only therefore try and take the "mean tint" for a day.

Following are some miscellaneous observations and remarks culled from different observers' notes.

The Director studied the star pretty carefully on the evening of Feb. 22, with a view to detecting anything abnormal about its appearance as seen in a $2\frac{3}{4}$-inch telescope. With magnifying power of 67 it looked white with cast of blue; no small stars seen in very close proximity to it. With power 120 nothing more was seen. There was *apparently* a small disc, but probably this was only the usual stellar (false) disc, with the usual diffraction rays. With power 200 the disc looked a pale straw colour, with diffraction rays. On the whole there was on this day nothing visible by which the Nova could have been differentiated from any other star.

Mr. Scriven Bolton thinks the star might have remained longer visible to the naked eye had it not turned such a deep red colour.

Mr. Grover remarks that on March 1, it was distinctly seen in the 6·4 in. refractor of the Rousdon observatory a few minutes before noon, and in bright sunshine.

Mr. Crommelin states that the image in the 28-inch refractor of the Royal Observatory looked "stellar and single."

Mr. King remarks that on February 28 the Nova twinkled more than either α Persei or Algol. The latter was vertically below the Nova, and therefore, under ordinary circumstances, should have shown more scintillation. The Director confesses that when he observed it on February 22, the light seemed to be remarkably soft and steady.

PHOTOGRAPHS.

Mr. A. Smith, of Dalbeattie, N.B., has been so good as to prepare several photographs of the Nova specially for this Memoir and they appear as Plate I. and the map showing the vicinity of the Nova. I cannot do better than give his notes on them in extenso.

Description of Photographs comprising Plates I. and V.

By ALEXANDER SMITH.

"Plate I. is a photograph of the vicinity of Nova Persei. It was taken on August 16 with an exposure of $1^h\ 25^m$, and embraces a region of about $9\frac{1}{2}$ degrees in declination and 36^m in right

1 p. 4644.

ascension. The Nova will be readily recognised by those who are familiar with the region as the prominent star a little below, and to the left, of the triangular group known as Nos. 2896, 2898, and 2899 (Bonn A.G.C.) This group is nearly equidistant from the two bright stars β (Algol) and δ Persei, the former being depicted at the lower right hand, and the latter at the upper left hand, corner of the plate.

"With one exception the series of 8 photographs comprising Plate V. are enlarged images of the Nova, the original negatives being taken either on different dates or under different conditions.

"No. 1 is a negative impression, enlarged to about 13 diameters, from a photograph taken on 22 March, with an exposure of $1^h\ 10^m$. The disc is similar in general appearance to that of a bright star of the ordinary type, and for the purpose of comparison there is shown at No. 2 an enlarged image of Vega, which was obtained with the same appliances, and with practically a similar length of exposure viz., $1^h\ 15^m$. The edge of the Nova, though perhaps more sharply defined, has a less regular outline. It also exhibits a trace of halation, which assumes a form not at all unlike that of the corona as shown on photographs of a solar eclipse. It may, however, be here noted that halation is totally absent on all photographs of the star taken by me on subsequent dates. A careful examination of the original negative under magnification, and projected against a strong light, also shows that there is a decided darkening at the centre, and traces of the features, which became so prominent at a later stage, can just be detected. Mr. Henry Ellis drew attention to this in a paper communicated to the Association in March,* and, in referring to the result of an exposure made by him with a portrait lens on the 5th of that month, pointed out that the image of the star showed a "central condensation of silver"—a peculiarity which was not exhibited by any other star on the plate.

"No. 3 is an enlarged view of the Nova taken from the August negative, which forms Plate I. What is now familiarly known as the "aureola" had at this date become conspicuous, the bright centre being surrounded by a well marked fringe of nearly $2'$ in diameter. A photograph taken with a $6\frac{1}{2}$-in. portrait lens by Mons. Antoniadi on August 20–21, with an effective exposure of $3^h\ 20^m$ showed a less distinct but larger aureola of $6'$ in diameter, which was faintly seen on another photograph taken with an exposure of 30^m. Mr. Henry Ellis, using a portrait lens of 5-in. aperture, obtained a similar effect with an exposure of $3\frac{1}{2}$ hours, but neither my August negative nor another taken on September 22, with an exposure of $2^h\ 10^m$, shows any trace of it. Further exposures of 1^h were made by Mons. Antoniadi on October 3 and November 1, and of $1^h\ 30^m$ on November 2, with the result that the larger fringe was altogether absent, from which it may be inferred that the rays giving rise to it must have diminished in intensity during the autumn.

"On October 10 I put 10 photographs of the star on the same plate, and No. 4 is the result, enlarged to 14 diameters, of two of these impressions. The appearance of the aureola, though different to that of the August photograph, is similar on all the

* *See* "Journal," Vol. XI. p. 243.

exposures made on October 10, as well as on further photographs taken on the two following days.

"No. 6 shows the resulting image from two exposures made on October 19 with half the lens aperture covered by a semi-circular disc. The effect, as will be noted, is to cut off half the aureola, while the bright circle remains complete. This experiment appears to have been first applied to the Nova by Professor Max Wolf, of Heidelberg. It clearly proves that the aureola has no objective existence, and must consequently be due to rays of a different wave-length to those emanating from the ordinary type of star, and which the achromatic lens fails to bring to a focus at the normal focal plane. The achromatic lens, unlike the parabolic reflector, which brings all rays to a common focus, has, in this instance, the property of filtering out, so to speak, the actinic effect of those rays of high refrangibility which give rise to the aureola. From a further series of experiments carried out by me on November 13, I learned that the aureola radiations came to a focus ·092 in. beyond rays of the normal type, and photographs Nos. 5, 7, and 8, which are enlarged to precisely the same scale, illustrate the method by which this result was obtained. No. 5 shows the appearance of the Nova on the date referred to at the focus of ordinary stars. No. 7 is the result obtained ·046 in. beyond, where the aureola has decreased in size and the central disc increased until the two images are superimposed. At this point neither class of rays would be in focus; but if the latter is extended to ·092 in., or double the distance at which the images become superimposed, we should get within a very small error the focal distance of the aureola producing rays. No. 8 is the effect obtained by a half aperture exposure of 30 min. made at this plane, and it is interesting to compare the results with photograph No. 6. In the one case we get the actinic effect of the out-of-focus aureola rays ·092 in. within their proper focal distance or at the focus of ordinary stars, and in the other the effect of the out-of-focus normal rays at a similar distance beyond or at the focus of the rays giving rise to the aureola.

"Between 22 March 1901 and 31 January 1902 I have taken 51 photographs of the star with exposures ranging from 2^h 10^m down to 5^m, the total exposures amounting to over 18 hours. An examination of the whole results shows that the comparative diameter, which the central disc bears to the outer fringe, has been undergoing a gradual change. This will be readily noted by referring to photographs Nos. 3, 4, and 5 taken in August, October, and November. In the August and November photographs the central discs are similar in size, although in the former the image has been enlarged to 14, and in the latter to 26 diameters. I estimate the central disc on 31 January to be equal to star No. 2899 or about 9th mag. As pointed out in a paper communicated by me to the December meeting of the Association,* if the decrease in the normal rays continues, and if the intensity of the aureola radiations are maintained, a stage would ultimately be reached when a photograph of the Nova taken at the focus of stars of the normal type would exhibit the actinic effect of the

* *See* "Journal," Vol. XII., p. 118.

aureola rays only, and, while the resulting image would lose the lustre of a star, it would bear a resemblance to a small, but well-defined, planetary nebula. On the other hand, as the brightness of the star diminishes, the aureola may disappear from the photographic plate before the central image, but the point raised would seem to be worthy of further investigation."

With reference to the preceding notes, it may be remarked that Mons. Antoniadi on October 30 informed the Director that the aureola cannot be objective.

Mr. Tomkins, of Allahabad, India, while taking a series of sky-photographs to test a small lens with a view to photographing star trails, by a most singular piece of good fortune, happened on February 22 at 10^h p.m. local time ($= 4^h\ 33^m$ G.M.T.), to take that very portion of the sky in which the Nova was situated (*see* "Journal," Vol. XI., p. 242). By a piece of ill-fortune this plate has been since broken while in transit through the post. Before this accident, however, the brightness of the Nova, as shown on the said plate, was estimated as well as could be, by the differential method; that is, the brightness or size of the disc was compared with that of other stars on the same plate. It was found to be about 1·2 mag.† Mr. Tomkins has, therefore, secured a record of brightness at an hour when daylight prevented observations in Europe; moreover, it is the first record, in point of time, *after* the discovery.

In addition, Mr. Tomkins then took a series of photos of the Nova and its vicinity, principally with the same lens (viz., a magic lantern lens of 2-in. aperture). Owing to the difficulty of comparing photographic with visually determined magnitudes, it was thought best that only the photograph of February 22 should be taken account of in the Light Curve. However, the magnitudes of the Nova have been estimated as well as possible on these photographs, and are shown in the following table:—

No. of Plate.	Date.	Magnitude.	No. of Plate.	Date.	Magnitude.
40	Feb. 22	1·2	54	Mar. 10	3·4
43	„ 28	0·8	55	„ 11	3·5
44	„ 28	1·6(?)	56	„ 13	3·6
46	Mar. 2	2·8	57	„ 15	3·5
48	„ 2	1·8	58	„ 16	3·6
49	„ 3	1·7	59	„ 19	4·93
50	„ 3	2·0	60	„ 21	3·6
51	„ 5	2·9	61	„ 22	5·25
52	„ 5	1·5(?)	62	„ 25	5·25
53	„ 8	3·5			

A lantern slide prepared from a photo taken on March 12, with a stationary camera, by Mr. A. E. Murray, of Upper Walmer, Kent, is an excellent production, and gives the trail of the Nova most clearly. It looks in brightness about equal to that of Algol. Considering this was a first attempt at photographing stars, it is all the more creditable to Mr. Murray.

† The mean of two independent observations by Mr. Child and the Director.

SPECTROSCOPIC OBSERVATIONS.

This department of astronomy hardly comes within the province of the Variable Star Section, and there are, perhaps, no experts on the subject within the Section. Some general remarks only can therefore be offered on the subject, based on observations and on one or two papers of a high class kindly sent in to the Director.

Knowing the importance of such observations, but being without any really adequate means, the Director, on the evening of February 22, applied a Browning's miniature spectroscope between the eye and a low-power eye-piece of a $2\frac{3}{4}$-in. refractor. The light of the Nova was quite strong enough to furnish a brilliant spectrum through all these lenses and prisms. The spectrum thus visible was apparently continuous, without either dark or bright lines.

Mr. Edwin Holmes got his first look at the spectrum (of which he sent a sketch) on February 28. A most astounding change had taken place. The star was of a golden colour, and the spectrum the prettiest he had seen; type of Nova Cygni. The red line and the yellow were very intense. Those in the violet, faint. Instrument, $12\frac{1}{4}$ in. with reflector and a spectroscopic eye-piece.

As soon as possible a McClean's star spectroscope was obtained by the Director, and on March 3 the change in the character of the spectrum was at once noted. It was broken up into three beautiful groups or clusters of bright lines. One of the most interesting to the Director was the deep crimson line, isolated in the dark end of the spectrum; the beauty of whose colouring can never be forgotten. On March 6 many dark, fine lines were suspected by the Director in addition to the bright lines. On March 12 only one bright band could be seen, viz., in the violet. March 16, the red line had absolutely vanished.

Mr. Holmes' observations continue as follows:—March 3, red line brightened up again, but yellow faded. Violet plainer than before. March 5, yellow line rather a broad band now. March 10, red line brightest, but yellow quite gone, as a line. Blue next in brightness. Mr. Holmes remarks in a letter dated 15th March that the continuous spectrum appeared brighter than the spectra of other stars of equal magnitude. The red, the middle green band, and the blue are very bright. It is remarkable that the yellow, which was very vivid at first, is gone, and the violet more plainly visible. He failed to see the numerous fine dark lines suspected by the Director.

On March 21, Rev. R. Killip first saw the spectrum which he thus describes:—C line, bright and sharp. D rather faint with dark band on more refrangible side. E and F bright broad bands. Many other bright and dark bands, difficult to identify. Star spectroscope on 5-in. Wray refractor.

Mr. Holmes' observations continued:—March 24, the spectrum had faded very much as a whole. Red line still distinct. Mere traces of yellow. Three green bands of nearly equal intensity. Blue band luminous. A very faint band in the indigo, and another

high in the violet. No fine dark lines. March 26, Nova less red, rather orange, yet red line brighter than on 25th ; also yellow brighter. The first green band hardly distinguishable ; the next, plainer and broader ; and the next, still broader. Blue as before. In the indigo a broad band, only faintly more luminous than continuous spectrum, and very high in the violet a narrow faint line. March 30, star much less red in telescope, yet the red continuous spectrum brightened again. Red line or band fairly plain, but not brightened so much as continuous spectrum. Yellow just seen. Only two green certain, and blue less luminous. Band in the indigo, and faint one high in the violet visible. With Thorp grating, the red, yellow, and blue came out as coloured knots.

Mr. Holmes continues : "If I am right (by which I mean if these changes are not atmospheric), the spectrum undergoes continual changes. The red line and the blue have been most steady, but the red went very dull, and has since brightened again. The yellow from being very bright has faded to invisibility, and since become perceptible ; singularly, it is more perceptible with Thorp grating when the spectrum is a mere line. The greens have faded, I think, continuously, but variably ; sometimes the middle one has appeared the brighter, and sometimes the most refrangible. The band in the indigo has certainly become very broad, and I have queried whether it is not the result of contrast from the spectrum on each side being covered with fine lines not individually visible to me."

Miss M. A. Orr took a note of the spectrum on March 25, and observed (1) a vivid patch of pure red, (2) a dull red or orange band, (3) and (4) yellowish or colourless, the more refrangible the brighter of the two, and succeeded by a dark gap. On March 30, spectrum similar, but perhaps continuous spectrum between (1) and (2) is brighter.

It will be seen that the preceding observations relate entirely to the general appearance of the spectrum ; the identification of lines, and measurement of their positions, are naturally the work of those provided with proper appliances.

A valuable paper by the Rev. W. Sidgreaves, S.J., F.R.A.S., "Notes on the spectrum of Nova Persei," was forwarded to the Director, and was read before the meeting of the Association held on April 24, 1901. The Rev. Father supports Mr. Holmes' observations as to the variability of the yellow band. "A bright yellow band (possibly D) was sometimes seen more prominently than at other times, possibly when the continuous spectrum was weaker the contrast was greater." He also remarks, "On March 22, 25, and 28, the star's magnitude appeared, from unaided eye comparisons, to have been at marked minima, and the spectra on these dates have a corresponding character. The continuous spectrum is very much weaker, almost nil, while the blue broad band between $H\beta$ and $H\gamma$ stands out quite strongly ; nearly if not quite as strong as $H\beta$, thus asserting itself to be a true bright band. $H\zeta$ has a most remarkable extension on the violet side, covering nearly the space to the position of $H\eta$, and no other lines show beyond this, although there is a clear trace of continuous spectrum considerably beyond $H\zeta$, and the other bright bands also appear well but not so strongly."

THEORIES.

We can only glance generally at the theories that have been put forward to account for the outburst of light which has thus reached us from such an incredibly great distance. And here, where the doctors disagree, it is permissible for amateur astronomers to hold their judgment somewhat in suspense, on account of the vast difficulties surrounding the subject, and our ignorance of the real essence of cosmical physics. Firstly, then, it would appear that Nova Persei, or the central point of light which we may call the star, or nucleus proper, has no very appreciable parallax. If it had one of over 1″, it would very probably have been detected ere this. Say it is as much as 0″·5, then the resulting distance is 6·5 light years. So that we may fairly assume that the distance is considerably greater than this—*how much* it is impossible to say, until organized attacks on the parallax shall have been made by several of the first class observatories. Secondly, the proper motion is stated to be nearly 1″ (A.N., 3756), so that it would be 60 years before it had shifted its place on the sky one minute of arc as regards the neighbouring stars.

To all intents and purposes, then, the Nova may be regarded as pretty firmly fixed in its place on the celestrial sphere.

The dominant idea of the prime cause of the outburst seems to be a collision between two bodies, rather than a purely chemical or electrical explosion within a single isolated body. Now, in the realms of space we have to deal with stars (suns), with nebulæ, and with meteoric swarms, without perhaps mentioning the now usually accepted "dark bodies" of space. Here are four classes of celestial bodies; take any two of them, and assume them to be in motion relatively to each other. Now work out the possible combinations, and we shall get a large variety of supposed conditions. For example, a star may have met another star, or it may have gone through a nebula, or through a swarm of meteors. Meanwhile, the vast distance of the stars masks any motion in space, beyond what is seen as radiating from a central nucleus.

The relative speed may be practically anything for all we can tell; it is even possible one body might have caught up another, both going in the same direction, but one much faster than the other.

Then the angle between the courses or tracks of the bodies might be anything, from 0° round to 180° again.

The character of some nebulæ, such as the great nebula in Orion, we know to be marvellously involved and intricate, and our supposed nebula may be full of curdling masses of gas of all possible shapes and sizes, interspersed with dark rifts and vacuities. If we now sum up all these just-mentioned conditions, viz., four classes of bodies, their varying positions, motion, character, &c., it will be patent at once that there is an infinite variety of conditions, on the coincidence of which may follow a conflagration exceeding in vastness and complexity anything we can dream of, and, therefore, there is here much scope for the imagination of theorists.

Speaking with great diffidence, and without claim to anything more than a smattering of celestial physics, it seems possible that the outburst might have been caused by the rush of a comparatively small, solid, or perhaps gaseous, body, through a huge extended nebula, which latter might have various degrees of condensation, and thus might exhibit various degrees of brightness due to the glow following on the impact with the various condensations. We *do* know from the Lick photographs that visible nebulous matter exists in patches *round* the bright centre of Nova Persei. The latest news is that two oval nebulous rings surrounding the Nova were photographed at the Lick Observatory so far back as March 29, 1901. It is thought that these rings, which on the date named were quite small, may have expanded into the larger ones which were photographed later.

But this visible or photographic nebula (*not* the aureola, mind, which is understood to be no real phenomenon) lands us in great surprises. With a parallax of say o″·5, the dimensions of these nebular rings run into astounding figures. Taking the apparent radius of the nebula photographed at the Yerkes Observatory at 6′, I find that the real corresponding radius comes out over 66,000 millions of miles, or 23 times the distance of Neptune from the sun! Motion has been observed in certain condensations in this nebula, which utterly transcend what we are generally accustomed to in astronomy. Mr. Gore finds that the velocity of projection of the nebulous matter (if matter really *is* projected), would be over 6,000 miles a second. Hence Prof. Kapteyn's idea that light may have radiated out from the central source of brightness, reaching in turn various parts of the nebula, which in turn again reflect the light to us. So we are supposed to have seen the central parts of the nebula first, and the outermost parts later, and both by reflected light.

No theory put forward can be regarded as satisfactory which does not account for the extraordinary light vibrations set up on March 18, and continued for some weeks afterwards.

When we read about the difficulties which exist in interpreting the spectra of the star, either photographed or visual, one can only surmise that we are far from having arrived at finality in this department of astronomy, even if the foundation has yet been securely laid. We have to consider that our spectroscopes differentiate the complex radiations emanating from an enormous nebulous mass in a state of violent chaos. Some parts of this mass may cause absorption spectra; other parts spectra with bright lines; and there will perhaps be a continuous spectrum behind all. Then again one part may be in rapid motion towards us, and another away from us, so that the two sets of lines throughout the respective spectra are all shifted to a corresponding extent, relatively to one another. We may have a space between two bright lines and not be able to say whether it is continuous spectrum or a genuine dark line, and the same with a bright space between two dark lines.

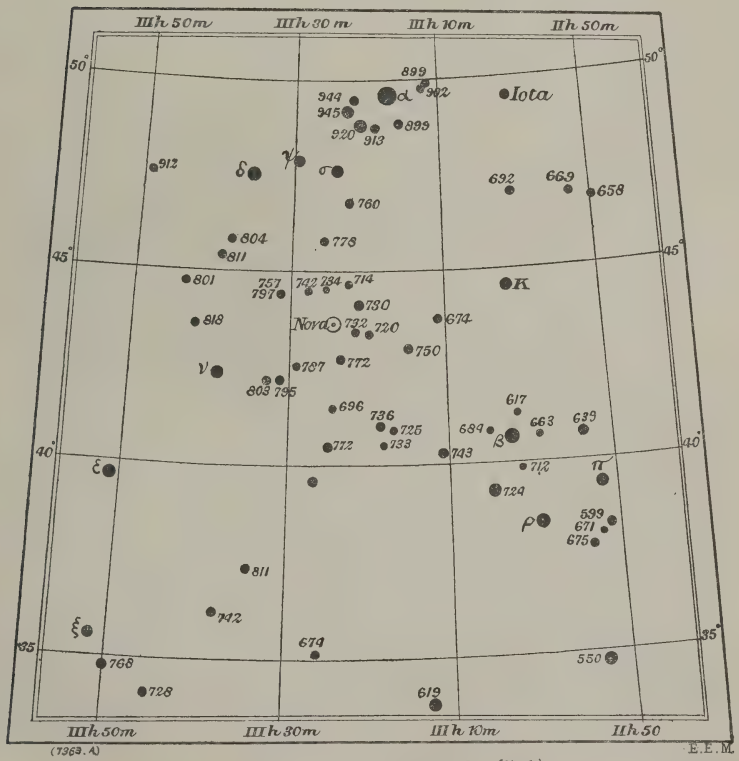
Such are a few of the enormous difficulties met with in dealing with this wonderful star. We do not mention them to discredit in any way the work of physicists, rather to urge them onward towards the goal, where we may hope to have a fairly sound

general idea of the sequence of events in the Nova, but we *do* mention them to show how dark and shifting, in many respects our way at present is.

And what may we anticipate as to the future of Nova Persei? With limited experience it would be rash in the extreme to make any definite forecast whatsoever. No one, of course, can say that there may not be a recrudescence of brightness, although slight, as in the case of Nova Aurigæ. At present, however, the light seems to be gradually and slowly fading; and we anticipate generally that this will go on until it reaches a period of steady and quiet light, stellar or nebulous—

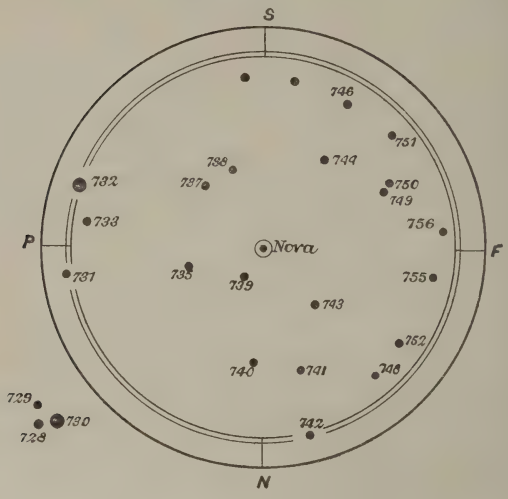
"Last scene of all,
That ends this strange eventful history."

No. 1.



VICINITY OF NOVA PERSEI (1901)
Showing the principal
Opera Glass Stars
Scale 1 Ins. = 5 Degs
EPOCH 1900

No. 2.



TELESCOPIC FIELD
$\frac{1}{2}$° RADIUS FROM NOVA PERSEI
Giving the principal stars in the vicinity
The numbers attached to stars are from the D.M.

No. 3.

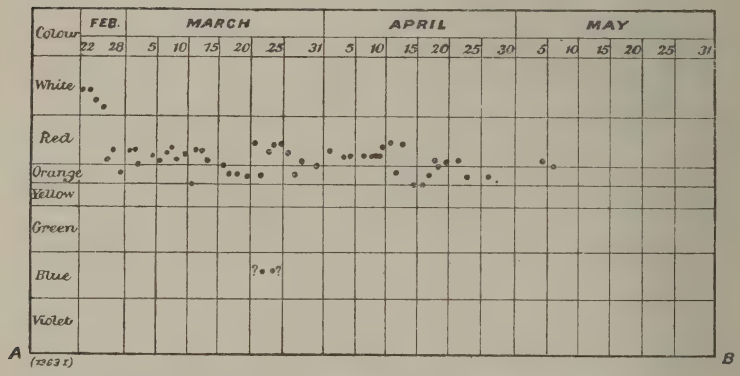


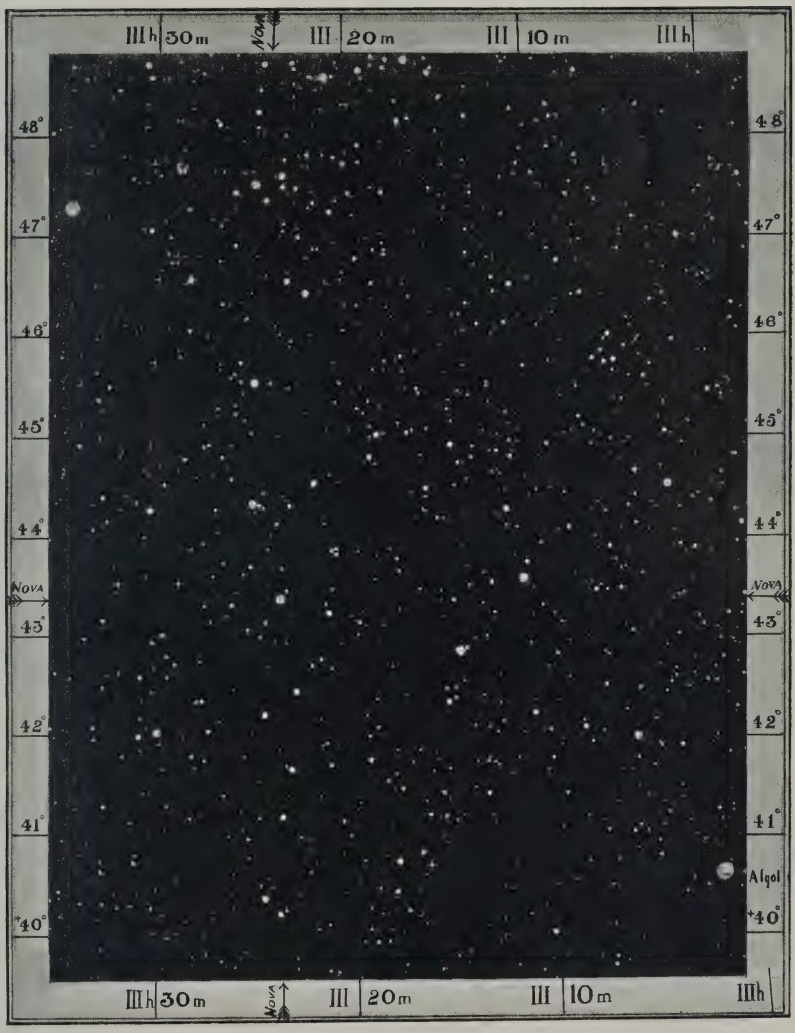
Diagram shewing changes in colour of NOVA PERSEI.
as observed by Members of the B.A.A.

H.M. Gun Wharf, Devonport,
1902 March 23.

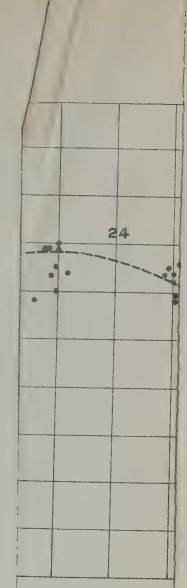
E. E. MARKWICK, Colonel,
Director of Variable Star
Section.

PHOTOGRAPHIC CHART

OF STARS IN THE VICINITY OF NOVA PERSEI.



From negative taken by ALEXANDER SMITH, Dalbeattie, on 16 August, 1901.
Exposure 1 h. 25 m.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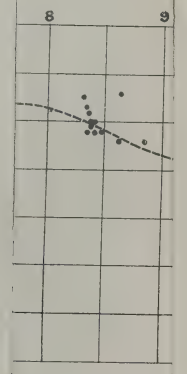
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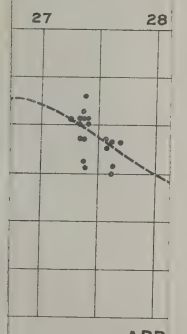
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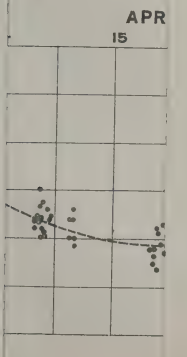

APR
15

LIGHT CURVE OF NOVA PERSEI (1901)

DRAWN BY J.E.GORE, F.R.A.S, M.R.I.A.,

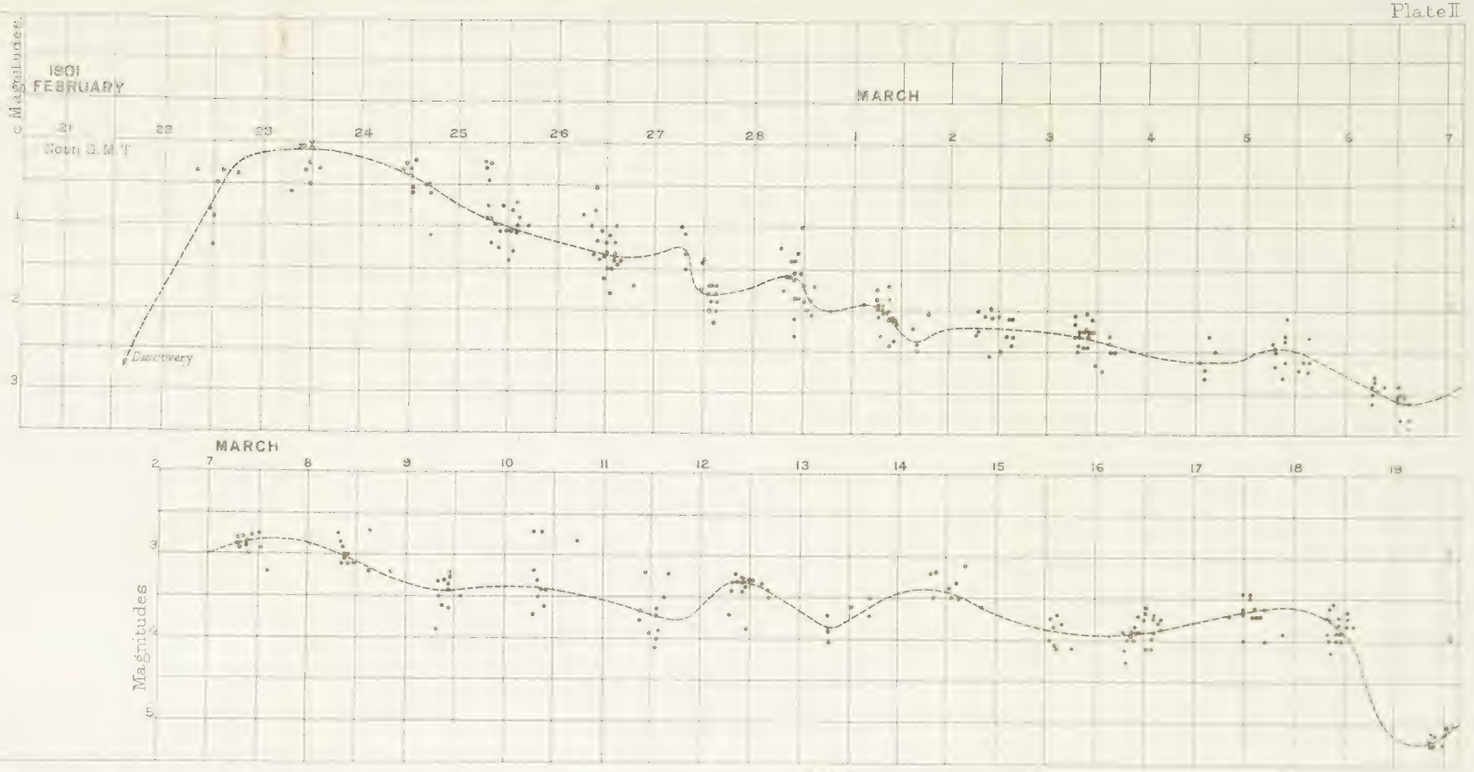
From all the best observations made in Great Britain & America.

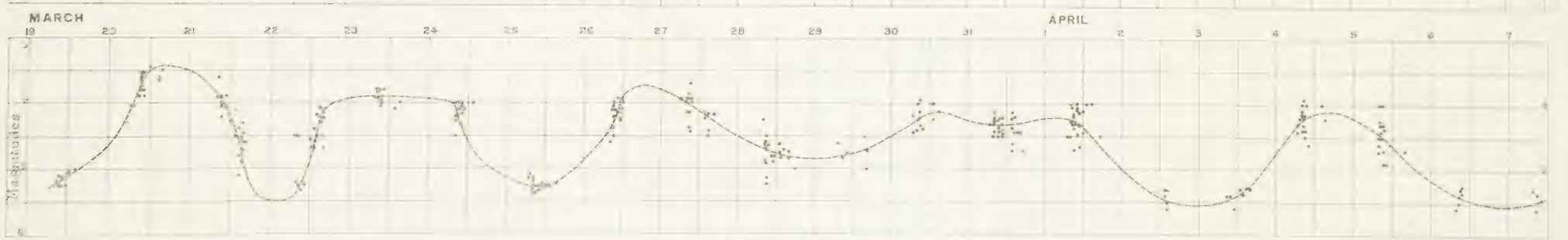
Harvard scale of magnitudes.

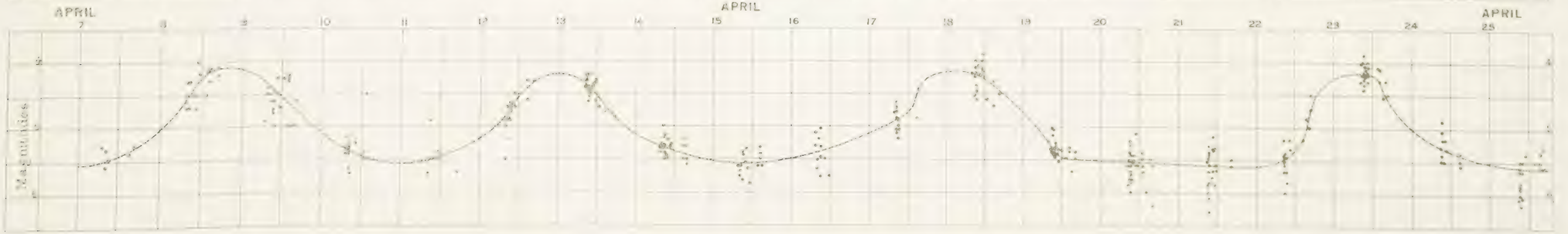
Horizontal Scale; 1 Division = 12 Hours.

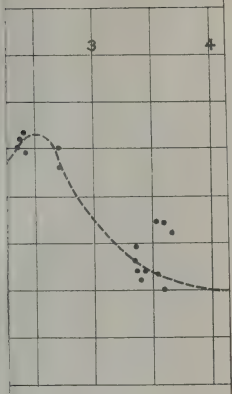
Vertical Scale; 1 Division = 0·5 Magnitude.

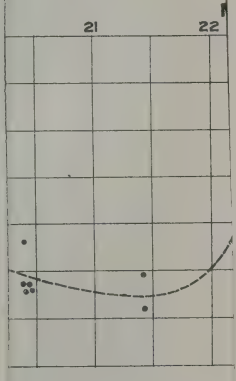
Greenwich Mean Time.

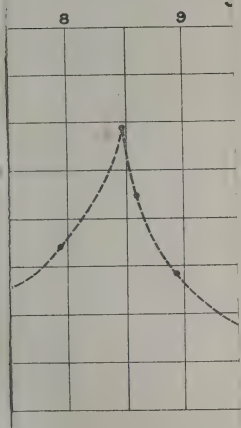


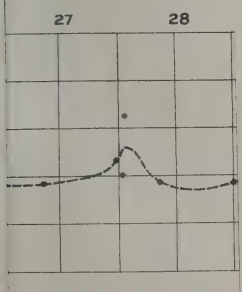












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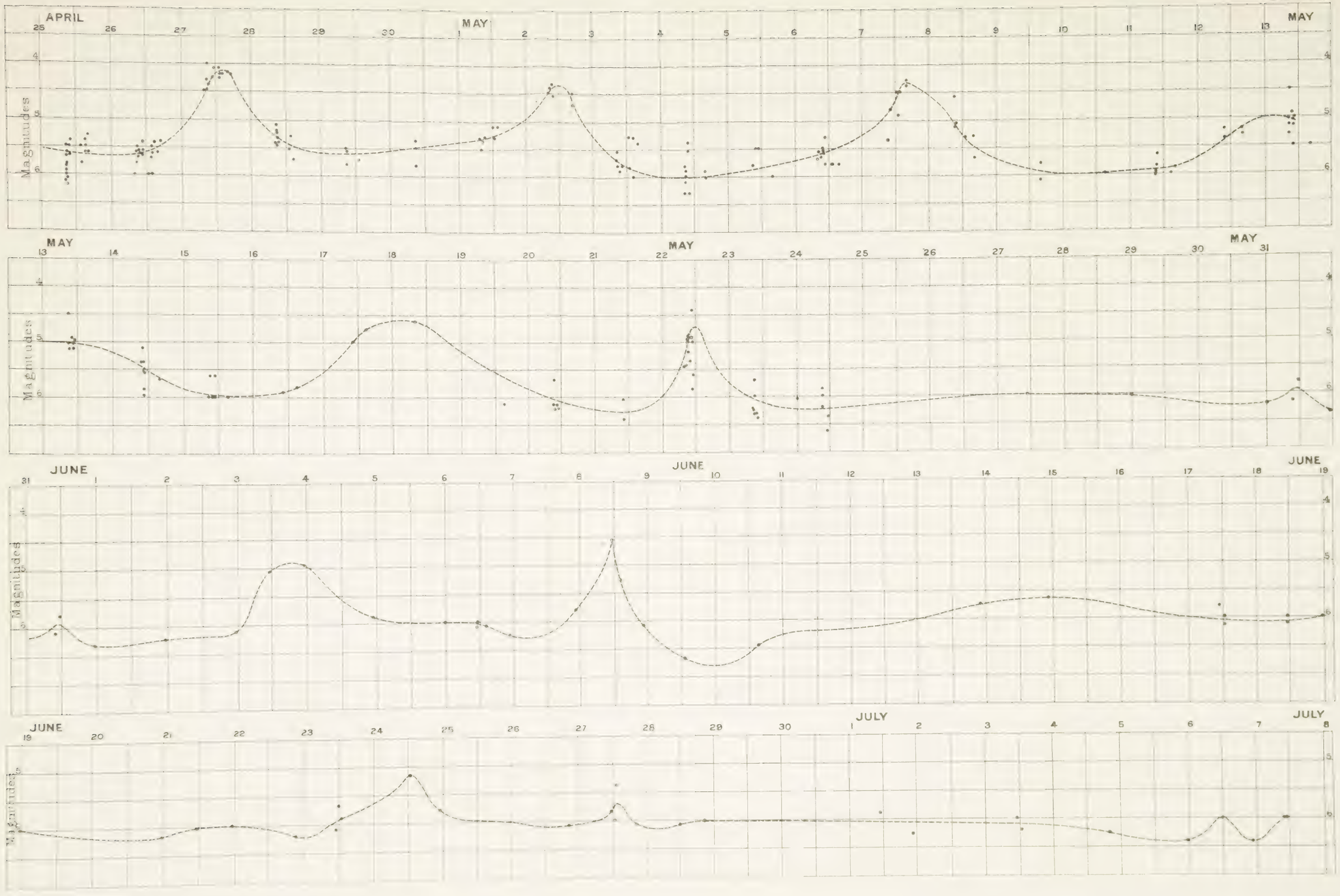
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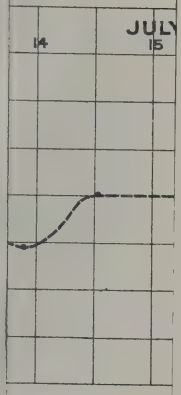

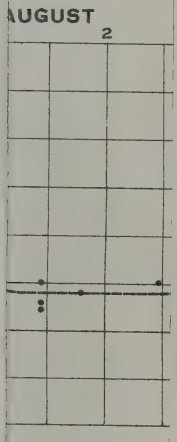

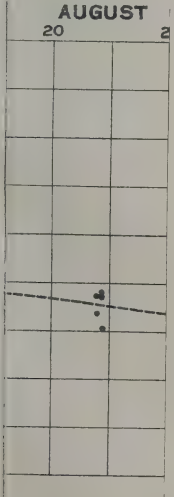

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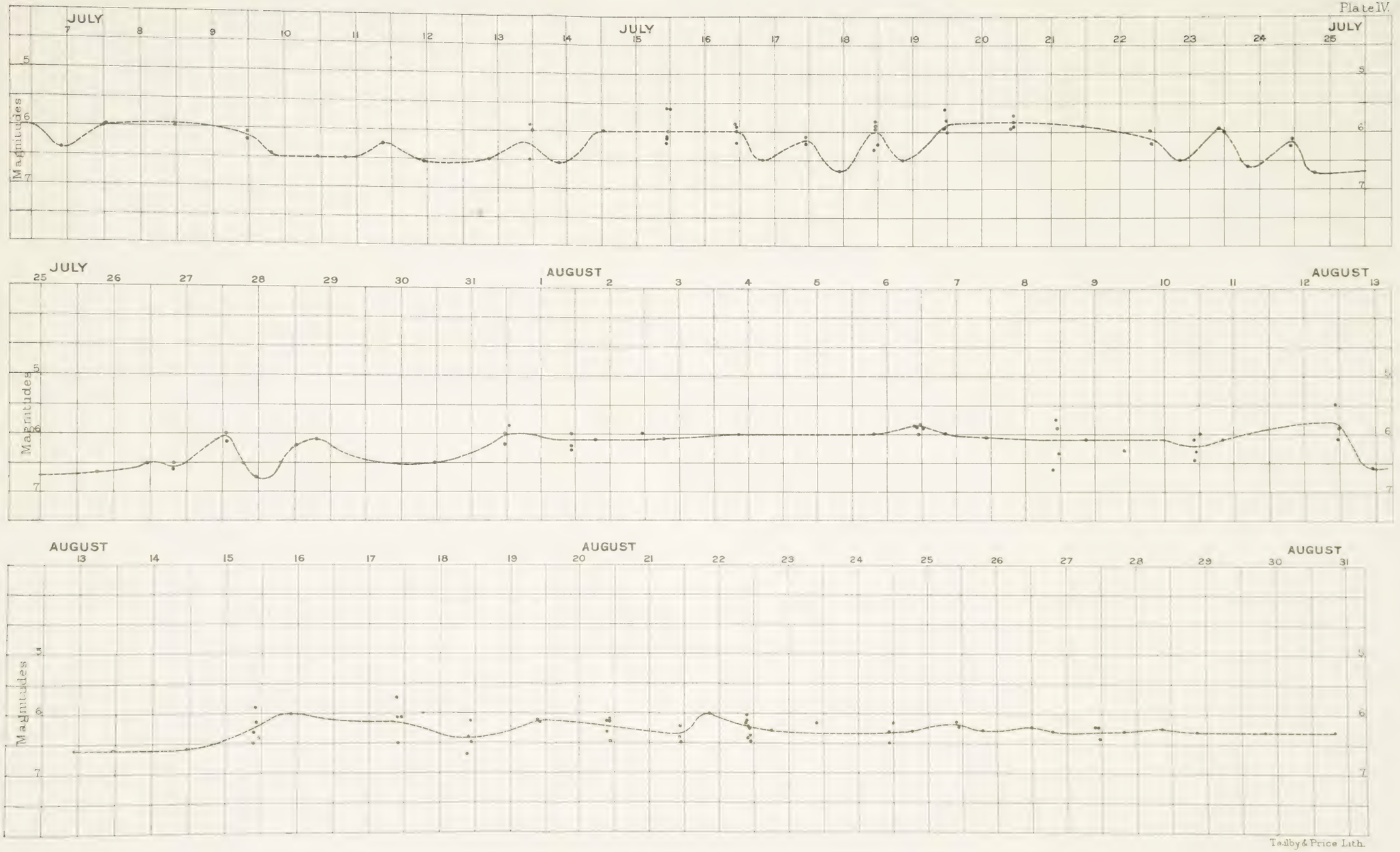
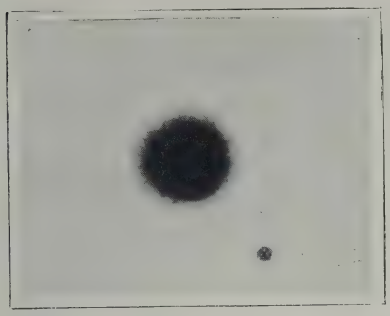
Plate IV.



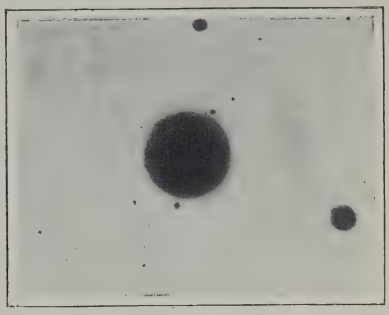
Tadby & Price Lith.

NOVA PERSEI.

From negatives taken by ALEX. SMITH, Dalbeattie. Lens used 5¼ in. doublet.

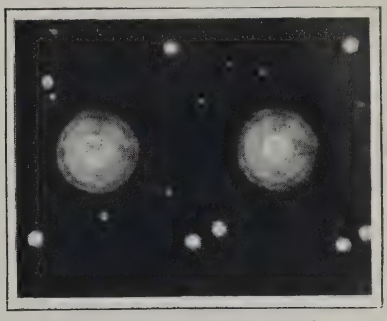


No. 1. Negative Image of Nova.
22 March, 1901. Exposure 1 h. 10 m.

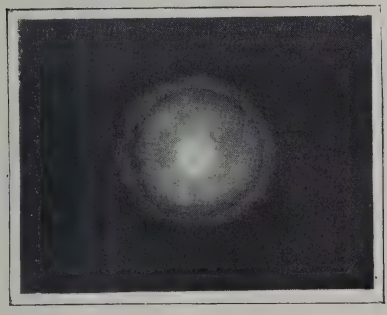


No. 2. Negative Image of Vega.
14 May, 1901. Exposure 1 h. 15 m.

No. 3. 16 August, 1901. Exposure 1 h. 25 m.
(Enlarged 14 diameters.)



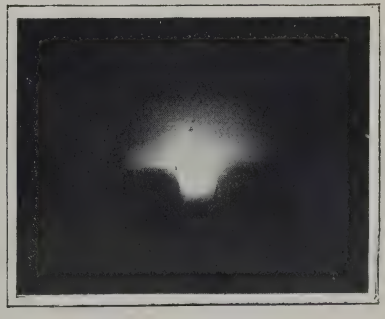
No. 4. 10 Oct., 1901. Exposure 1 h. 15 m.
(Enlarged 14 diameters.)



No. 5. 13 Nov., 1901. Exposure 8 min.
(Enlarged 26 diameters.)

No. 6. 19 Oct., 1901. Half Aperture Exposure of 20 min. at normal focus.

No. 7. 13 Nov., 1901. Exposure 8 min. at .046 in. beyond normal focus.



No. 8. 13 Nov., 1901. Half Aperture Exposure of 30 min. at focus of aureola rays.

SECTION FOR THE OBSERVATION

OF

JUPITER.

DIRECTOR.—ARTHUR COTTAM, F.R.A.S.

NINTH REPORT OF THE SECTION.

PART 1.

INTRODUCTORY.

This Memoir is divided into four Parts, instead of the usual division into five, as the notes that have been received with reference to colours and colour changes are included in Part 2.

Part 1 is, as usual, introductory; Part 2 contains the general disc observations; Part 3, observations of spot transits; and Part 4, satellite observations.

The drawings that have been received are not numerous, and the three observers who have contributed the majority of them have each sent a chart. These charts have been reproduced, and probably will be more useful than a series of disconnected drawings.

Since the last Report two Members have joined the Section, Mr. John Bullock, of Eyot Cottage, Chiswick Mall, and Miss Catharine O. Stevens, of the Red House, Bradfield, Reading. The name of one Member was inadvertently omitted from the last list, that of Señor José Comas Solá, of Gerona.

The following Members have sent drawings of the Planet as seen by them during the apparition of 1900.

Name.	Locality.	No. of Drawings.
SCRIVEN BOLTON - -	Leeds - -	95, and two charts.
JOHN BULLOCK, M.A. -	Chiswick -	2.
F. J. GARRARD - -	Louth - -	7, and a chart.
Capt. P. B. MOLESWORTH. R.E., F.R.A.S.	Ceylon - -	a chart.
Rev. T. E. R. PHILLIPS, F.R.A.S.	Yeovil - -	1.
H. J. TOWNSHEND - -	Leeds - -	6.

Of these drawings those by Mr. Bullock and Mr. Townshend only show any colours. Capt. Molesworth sent a number of drawings of portions of the disc showing spots, which have been returned to him.

Subjoined is a list of the Members of the Section, with particulars of their instrumental equipment, so far as the Director has information upon the subject.

Name.	Locality.	Instruments.
WM. ANDERSON, F.R.A.S.	Madeira	5-in. O.G.
E. M. ANTONIADI, F.R.A.S.	Juvisy	4½-in. and 9½-in. O.G.
ERNEST ATTKINS	Highgate	6½-in. spec.
E. G. AYLETT	Bredgar	8½-in. spec.
Rev. J. BAIKIE, F.R.A.S.	Ancrum	3½-in. O.G.
G. BANASTER, F.R.A.S.	Tewkesbury	4-in. O.G.
W. M. BAXTER	Edinburgh	—
SCRIVEN BOLTON	Leeds	4½-in. O.G.
LEO BRENNER	Lussinpiccolo	7-in. O.G.
J. H. BRIDGER, Mus. Bac.	Farnborough	4-in. O.G.
G. L. BROWN	Stirling	10½-in. spec. and 3½-in. O.G.
JOHN BULLOCK, M.A.	Chiswick	3-in. O.G.
R. W. BUTTEMER	Godalming	9½-in. spec.
B. E. CAMMELL, F.R.A.S.	Wokingham	12½-in. spec.
H. Y. CHILDS	Portland	4½-in. O.G.
J. E. CLARK, B.A., B.Sc.	York	—
E. J. COPE	Malvern	8½-in. spec.
HENRY CORDER	Bridgwater	6½-in. spec.
ARTHUR COTTAM, F.R.A.S.	Watford	12½-in. spec. and 4½-in. O.G.
Rev. Dr. CRAIG, B.A., F.R.A.S.	Londonderry	—
R. CROSS	Oxford	—
E. W. ELLERBECK, F.R.A.S.	Scarborough	6¾-in. spec.
HENRY ELLIS, F.R.A.S.	Potter's Bar	12½-in. spec.
E. ESSAM, F.R.A.S.	Billingboro'	12-in. spec. and 3-in. O.G.
J. EVERSHED, F.R.A.S.	Kenley	9¼-in. spec.
R. FALCON	Workington	—
Rev. T. H. FOULKES, M.A.	York	10½-in. spec.
A. FREEMAN	Hastings	10¼-in. spec.
W. F. GALE, F.R.A.S.	Newcastle, N.S.W.	5-in. O.G.
F. J. GARRARD	Louth	5½-in. O.G.
W. GOODACRE, F.R.A.S.	Crouch End	12½-in. spec.
H. F. GRIFFITHS	Streatham	6½-in. spec.
ED. HALL	Bjorneburg	5-in. spec.
W. J. HALL	Nantwich	4⅞-in. spec.
G. B. P. HALLOWES, F.R.A.S.	York	8½-in. spec.
A. HENDERSON	Liverpool	10¼-in. spec.
E. R. HICKS	Kensington	—
Rev. R. S. HUTCHINGS, F.R.A.S.	Salisbury	—
W. H. IZZARD	Brentford	—
J. JACKSON	Blackpool	—
W. E. JACKSON, F.R.A.S.	Liverpool	6-in. O.G.
Rev. S. J. JOHNSON, M.A., F.R.A.S.	Bridport	—
Rev. P. H. KEMPTHORNE, M.A., F.R.A.S.	Wellington College.	12½-in. spec.
Rev. R. KILLIP, F.R.A.S.	Liverpool	5-in. O.G.
N. LATTEY	Cardiff	8½-in. spec.

Name.	Locality.	Instruments.
J. LUNT, B.Sc.	Cape of Good Hope.	—
HY. MACEWEN, F.R.A.S.	Glasgow	5-in. O.G.
W. H. MAW, F.R.A.S.	Kensington and Outwood, Surrey.	6-in. and 8-in. O.G.
J. W. MEARES, F.R.A.S.	Calcutta	3-in. O.G.
ARTHUR MEE, F.R.A.S.	Cardiff	$8\frac{1}{2}$-in. spec.
F. K. MELLOR, F.R.A.S.	Huddersfield	$8\frac{1}{2}$-in. spec.
Capt. P. B. MOLESWORTH, R.E., F.R.A.S.	Ceylon	$12\frac{1}{2}$-in. spec.
J. M. OFFORD, F.R.Met.S.	Ealing	$12\frac{1}{2}$-in. spec.
J. ORR	Glasgow	$3\frac{1}{4}$-in. O.G.
Rev. J. D. PARKER, LL.D., F.R.A.S.	Stevenage	—
Dr. G. PATERSON, M.A.	Ascot	11-in. spec.
J. PHILLIPS	Hereford	15-in. spec.
Rev. T. E. R. PHILLIPS, M.A., F.R.A.S.	Croydon	9-in. spec.
W. T. PRICE	Wellington	$8\frac{1}{2}$-in. spec.
Rev. V. REID	Glasgow	—
C. ROBERTS, F.R.A.S.	Kensington	$6\frac{1}{2}$-in. spec.
Dr. RYLE, M.A.	Brighton	$2\frac{1}{10}$-in. O.G.
Dr. SMART, F.R.A.S.	Bermondsey	10-in. spec.
C. F. SMITH	Edinburgh	$5\frac{1}{4}$-in. spec.
H. F. SMITH	Luton	$3\frac{1}{2}$-in. O.G.
JOSÉ COMAS SOLÁ	Gerona, Spain	6-in. O.G.
Miss CATHARINE O. STEVENS	Reading	3-in. O.G.
W. C. STEWART	Clapton	—
Rev. W. SWINDLEHURST	Wickham, N.S.W.	—
C. A. TAYLOR	London	$2\frac{1}{2}$-in. spec.
H. J. TOWNSHEND	Leeds	10-in. spec.
J. M. WADMORE	Exmouth	$3\frac{1}{10}$-in. in O.G.
Rev. W. R. M. WAUGH, F.R.A.S.	Portland	$12\frac{1}{2}$-in. spec. and $4\frac{1}{2}$-in. O.G.
A. STANLEY WILLIAMS, F.R.A.S.	Brighton	$6\frac{1}{2}$-in. spec.
Rev. L. A. WILLIAMS	New Shoreham	$12\frac{1}{2}$-in. spec.
H. WRIGHT	Sidney, N.S.W.	$8\frac{1}{2}$-spec.
J. WYKES	Birmingham	$4\frac{1}{2}$-in. O.G.

PART 2.

GENERAL DISC OBSERVATIONS.

It has been the usual practice hitherto for the Director to write a condensed description of the principal features and characteristics of the markings on the planet from the disc drawings furnished by the Members of the Section.

This year the drawings are not numerous, owing to the low altitude of the planet, and hardly any of them are coloured. It is, therefore, proposed to allow such of the Members as have sent descriptions of the planetary features to speak for themselves.

The Director has taken the liberty of condensing some of the following descriptions, but he believes he has eliminated nothing that is important.

The first description is extracted from Capt. MOLESWORTH'S voluminous notes.

S. Polar Region.—Of a fairly uniform pale grey tint, with a very faint brownish cast (on rare occasions bluish). It does not seem to be much streaked this apparition, but the N. edge is generally decidedly darker than the rest and knotted in parts, forming almost a definite belt. The markings on this edge are generally very faint, and appear to be quite transitory.

S. S. Zone.—A faint zone separating the S. polar shades from the S. temperate belt. The white spots in it are very indeterminate and transitory, but two cases appear to give good results with a period of almost exactly $9^h\ 55^m\ 26^s$. The zone is too faint to show definite colour.

S. Temperate Belt.—The most southerly of the distinct Jovian belts having the most rapid period of the extra-equatorial regions. The colour is generally a decided bluish grey with darker knots and streaks in it. The rotation periods deduced from the various spots agree well *inter se.*

S. Temperate Zone.—Generally pale yellowish-white to milk-white, broken by circular and oval whiter spots.

S. Tropical Belt.—Dark and distinct almost always, the most prominent of the minor belts, having at times of best definition a well-marked bluish tinge in its grey. It contains numerous dark knots and streaks, and is, generally speaking, rather broad and irregular from $\lambda\ 281°$ to $342°$; was probably double throughout the apparition, but later the duplicity extended to $\lambda\ 261°$. At each end of this double portion was a white spot which almost completely interrupted the belt.

S. Tropical Zone.—Almost the brightest of the zones, distinct and brilliant, brightening to a milky white where it borders the S. equatorial belt, forming a series of shallow white bays.

Red Spot and Bay.—The bay enclosing the Red Spot continues visible with undiminished distinctness; the curve of the bay appearing quite symmetrical until late in the apparition, when the preceding slope appeared to be rather steeper than the following slope. The preceding shoulder is rather faint and frequently rounded. The following shoulder is dark and distinct; frequently projecting slightly S. of the nominal latitude of the S. edge of the S. equatorial belt.

The Red Spot still remains visible under the best definition, as a faint oval grey stain, darkest near the following end, and placed very slightly following the centre of symmetry of the bay. The S. edge appears to merge gradually into the S. tropical belt, while the N. edge is generally separated by a narrow, very white streak from the S. equatorial belt.

S. Equatorial Belt.—Very dark and uniform, broadly double for some distance preceding the Red Spot Bay, and generally rifted longitudinally. Its colour is a rather warm purplish grey,

tending almost to indigo at the darkest parts of the N. edge, and ruddiest just following the following shoulder.

The S. edge is scalloped into faint bays, separated by darker crests. As already stated, the centre of the belt is generally rifted, and, even when no distinct rift is visible, the centre is decidedly lighter in tone than the edges. This central rift contains whiter spots, the period of which is most difficult to discover, as they vary enormously in a short time, and are often very hard to distinguish as separate objects on the white ground of the rift, which undergoes very rapid changes.

The N. edge of the belt is generally very dark and well-defined, containing numerous dark spots, streaks, and masses. These often project considerably into the equatorial zone.

Equatorial Zone.—This has completely changed its tint since the last apparition. The orange-yellow colour tending to brown has completely disappeared, and the zone is now of a rather dull yellowish-white. The zone brightens considerably to the edges, and very white spots have been frequently seen bordering both equatorial belts.

Wisps have been seen in great numbers joining the dark spots at the inner edges of both equatorial belts. Sometimes they exhibit a remarkable parallelism, but at other times divide widely. They were undoubtedly fainter and of less frequent occurrence late in the apparition. In appearance they much resemble the streaks of the equatorial band, and have apparently a similar origin.

Equatorial Band.—A very faint, delicate, discontinuous band, lying nearly in the latitude of the Jovian equator.

N. Equatorial Belt.—Dark and fairly broad, but always narrower than the S. equatorial belt. In colour it was usually a warm purple-grey, generally rather ruddier than the S. equatorial belt, but this was not invariable.

The S. edge is very similar in appearance and composition to the N. edge of the S. equatorial belt, but the tendency to large, irregular dark masses is not quite so marked. The rotation period of some of the spots varies considerably from the average period, and most of the spots "wander" considerably. Considering these variations, and the general invisibility of the spots from April to June, I think the period obtained is reliable. It is the slowest period of the equatorial regions. (Last year, owing to insufficient data and wrong identification, an absolutely erroneous period was deduced for these spots.)

The centre of the belt is generally rifted, the rift at intervals brightening to very white spots. Some of these were very easily followed and well observed, and give a thoroughly reliable rotation period.

The N. edge, with the contiguous portion of the N. tropical zone, forms one of the most interesting portions of the planet.

This edge of the belt is sharp, dark and straight; but is broken up by circular white spots notched into the belt. The sharpness and brilliancy of these spots permitted of very exact observation,

and the results obtained are among the most reliable of the apparition.

The average number of observations of each spot in this zone was over 30. The period was, as a rule, uniform, and the drift of the spots regular, except between λ 180° and 270°, where the spots undergo a sudden and variable increase of period, the line of demarcation between the two regions being sharply marked. Between these limiting longtitudes the variations of period are often very large, and I have separated the spots which cross it from the rest as "abnormal." (*See* Table at page 97.)

The N. Tropical Zone.—A rather broad zone of a bright yellowish white, brightening to an almost phosphorescent white where it borders the N. equatorial belt.

N. Tropical Belt.—A discontinuous belt containing very dark streaks and knots at intervals. The colour is a decided bluish-grey in the darkest parts. The deduced period appears to be reliable in spite of variations.

N. Temperate Zone.—By no means a prominent zone, often hardly brighter than the surroundings, and generally dull. It contains a few slightly brighter spots which seem to be quite transitory.

N. Temperate Belt.—Faint, but practically continuous all round, containing several darker knots and streaks.

N.N. Zone.—A very faint zone, rather brighter towards the end of the apparition. It contains a few white spots.

N. Polar Regions.—Of a decided pale bluish-grey tinge extending to the pole. This region does not appear so much striated as last year. The darkest spots form a discontinuous belt along its S. edge.

SUMMARY of OBSERVATIONS of JUPITER, made at Hendford Vicarage, Yeovil, during the apparition of 1900, by the Rev. T. E. R. PHILLIPS, M.A., F.R.A.S.

The aspect of Jupiter in 1900 showed a few interesting changes as compared with that of the previous apparition.

The principal belts retained their positions and characteristics, but showed some variations in intensity.

The two great equatorial belts remained broad, and were again broken up by a series of light and dark spots along their northern edges. The northern belt was frequently seen to be cut through by bright rifts, which united white spots at its south edge with similar spots on the N. tropical zone. For some time during the apparition a portion of the N. equatorial belt became very vague and indistinct, especially along its N. edge. At the same time the spots bordering on the N. tropical zone in this region appeared veiled as if by mist. As in 1899, some of these N. tropical spots showed an altogether abnormal rate of motion; and it is probable that the unusual appearance noted was the result of the different velocities of the surface material in different longitudes of their belt and adjacent zone.

The following notes of the appearance of the N. equatorial belt were made:—

May 26.—Curious appearance of N. equatorial belt not seen before this apparition. Part of it very dark and decidedly red. Shadow of Sat. I. seen in transit upon the belt, closely followed by the satellite itself.

June 26.—N. equatorial belt in places vague and indistinct.

July 9*th*.—The S. equatorial belt much darker than the N. equatorial belt. The latter appears ragged and indefinite at the edges.

September 11.—White N. tropical spot (No. 24 in my paper in R.A.S., "Monthly Notices," January 1900), appeared to-night as a bright well-defined oval spot, much the same as last year. Seems now almost entirely free from the vagueness and veiled appearance of the past few months. (This spot on reaching $\pm\lambda$ 270°, System II., had exhibited a marked acceleration of velocity. During its rapid passage through the fainter region of the belt, it appeared indistinct and nebulous, but on emerging into more normal regions it regained its old brightness and sharpness of outline.)

The narrow band just N. of the equator appeared darker than in recent years, and exhibited a tendency to the formation of elongated dusky spots, especially where it was joined by the wisps from the N. edge of the great south belt.

The N. temperate belt showed a marked increase of strength, with several ill-defined dusky intensifications.

The N.N. temperate belt was unusually faint and inconspicuous.

The S. temperate belt showed a similar appearance to that of the past few apparitions, with several light and dark spots, the light spots extending across the S. temperate zone.

The S.S. temperate belt, as usual, showed several intensifications, which, as is always the case, exhibited very rapid motion. As a rule the belt appeared single, but was seen distinctly double on April 21.

A dusky cap was observed on several occasions at the S. polar regions.

The Great Red Spot was again exceedingly faint, but could be discerned at times as a dusky grey stain, somewhat darker towards its *f* end, where it was often seen bounded by a well-defined streak or wisp. This wisp connected the *f* shoulder with the S. temperate belt. The red spot again seemed not quite centrally placed in the bay, but to be somewhat inclined towards the *f* end.

As the visibility of the red spot was so largely dependent on the conditions of the atmosphere, it was again found better to observe and record the transits of the bay or hollow in which it lies.

The last observation obtained on 1900 September 25, at $5^h\ 29^m$, determined the position of the latter object as $\lambda = 44°{\cdot}9$. A comparison of this with a transit obtained on 1897, December 2, at $19^h\ 52^m$ ($\lambda = 18°{\cdot}9$) gives for the mean value of the 2481 rotations in the interval a mean sidereal period of $9^h\ 55^m\ 41^s{\cdot}67$. The spot has, however, shown unquestionable variations of velocity during the time included between these two observations.

Colours of the Disc.

The most striking change noted in 1900 as compared with 1899 was in the matter of the colouring.

The orange tone of the equatorial regions, which had been so marked a feature of the disc, practically disappeared, and the relative colouring of the two great equatorial belts became changed to such an extent that, during the greater part of the apparition, the N. equatorial belt was distinctly the redder of the two.

The following notes as to colour were made from time to time during the apparition :—

February 6.—Planet's disc much less highly coloured than during the two previous apparitions.

March 13.—Equatorial belts both grey. Orange tone almost disappeared from equatorial regions.

March 26.—Faint suspicions of red in equatorial belts, especially in N. equatorial belt.

April 19.—N. equatorial belt appeared red in twilight, especially at N. edge.

May 24.—N. equatorial belt appears distinctly redder than S. equatorial belt.

May 26.—Curious appearance of N. equatorial belt. Part of it very dark and decidedly red. S. equatorial belt not nearly so pronounced as this, and grey.

May 31.—N. equatorial belt deep red in colour.

September 11.—N. Polar region appeared somewhat bluish at times.

Mr. SCRIVEN BOLTON, of Leeds, sends observation as to the belts, &c. from which the following notes are taken :—

S. Polar Region.—Sometimes fainter than the N., and bordered by a fairly dark band. Usually warm in colour.

S. S. Temperate Band.—Never a very striking object. Often broader and fainter than the S. temperate band. It is the edge of a faint shading which grows much darker towards the S. polar region.

S. Temperate Band.—Invisible, except over the Great Red Spot at the beginning of the apparition; but towards the end of July and in August it presented much the same appearance as in 1899. By no means uniform throughout, and the broader portions often appeared distinctly double.

S. Equatorial Belt.—Usually very broad and dark, especially on the following side of the Red Spot hollow. The polar edge well defined and straight. The rift which divides this belt breaks through into the hollow under the preceding shoulder. In many places it forces its way through the N. component into the equatorial zone where it appears to form large white spots. All through the apparition 12 dark spots were seen on the N. component, nearly all of which were duplex, and usually situated about 30° apart.

From several transit observations the entire length of the Red Spot hollow was found to be nearly 40°. The following shoulder always appeared exceedingly dark, and possibly darker than any of the spots. The preceding shoulder, although comparatively faint, was quite clear in outline, and generally very cold in colour.

Equatorial Zone.—This zone grew comparatively faint towards the end of the apparition. Usually darker than the following side of the hollow. On several occasions there appeared to be no true dividing line between this zone and the N. equatorial belt. The slender equatorial belt was generally fainter than the wisps, which from their darkness were quite easy objects in spite of the planet's low altitude. Along the S. edge the zone is fringed with creamy white flocculent markings, often situated at the edge of the wisps.

N. Equatorial Belt.—As a rule almost as dark and broad as the S. equatorial belt. Throughout its whole length broken up by white spots, of which as many as four were often seen on the disc at one time. Both edges were very irregular, the S. edge being sometimes so diffused that it appeared to shade away into the equatorial zone. The narrow faint belt, lying only about 2° to the N., was always broken opposite the white gaps.

N. Temperate Band.—This appears to have undergone no change since 1899.

N. N. Temperate Band.—Quite faint, and not always equally defined. N. edge diffused.

N. Polar Regions.—Bordered by a faint band in about λ 55° or 60°. The darkest portion lies between λ 10° and 115°.

Mr. F. J. GARRARD, of Louth, Lincolnshire, sends the following general deductions from his drawings and notes :—

Polar Regions either differ in darkness in different longitudes, or were deceptive Generally appeared gently shaded down towards the temperate belts.

S. Temperate Belt.—Not by any means continuous, but broken in longitude 330° and 70°, and dotted from 250° to 300°. Perceptibly darker and wider about 340°, double from 80° to 160°. Very faint in parts. Probably quite continuous in an instrument of greater light-grasp.

N. Temperate Belt.—Continuous, mostly very faint, darker and more distinct about longitudes 150° and 250°, double nowhere. On the whole fainter than S. temperate belt.

S. Equatorial Belt.—Generally the darkest and most prominent feature, but about longitude 300° to 360° rather fainter. Double throughout the greater part of its length, but filled (as it were) by a lighter shading, very generally bordered on its S. edge by a light area. Its darkest parts probably the *f* shoulder of bay (longitude 68°), and spots (longitudes 75°, 95°, and 110°). Remarkable for the arched appearance of its N. edge, the points being dark and the arches filled by light areas. On the whole shows many *dark* spots, and few or no *white* spots. Great Red Spot whitish and faint.

N. Equatorial Belt.—Fainter than S. equatorial belt, not so wide, more sinuous. Its N. edge much more prominent than S. edge. Its dark portions long drawn-out curved lines. Its white areas sharply defined spots.

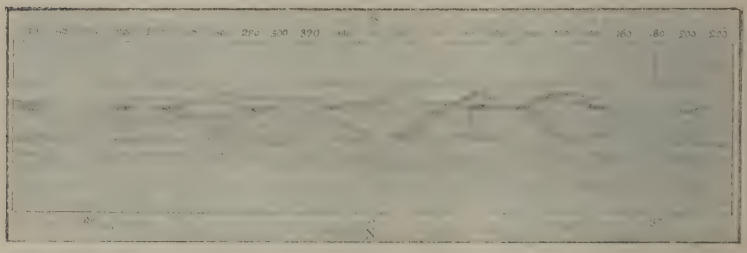


Chart of the surface of Jupiter, prepared from seven drawings made during the opposition of 1900. Instrument used, a $5\frac{1}{2}$-in. refractor, equatorially mounted; powers used, 120 and 160.—F. J. GARRARD, Louth, September 1900.

Equatorial Region.—Generally a little deeper in tint than rest of surface. Traversed by "wisps" connecting N. and S. equatorial belts, which mostly incline from *N.f.* to *S.p.* Also some looped wisps. In most instances wisps appear to connect dark spots or areas on S. equatorial belt with similar areas on N. equatorial belt. Also traversed by some light areas, as that in longitude 350° to 20°.

PART 3.

TRANSITS OF SPOTS, &C.

Capt. MOLESWORTH, in Ceylon, and the Rev. T. E. R. PHILLIPS, in England, have sent notes of these phenomena.

Capt. Molesworth's observations are so voluminous and elaborate that it is impossible to do justice to his work in the space of a report of this kind, and the responsibility of the Director is considerably increased, as he sends his original notes, and trusts the Director to make his own abstract of them.

As to the results of his observations he remarks:—"The observations for 1900 have been carried out on a much larger scale than anything I have hitherto attempted. Had I known the amount of labour they would entail, I should, I think, have hesitated before embarking on such a task.

"The reduction of the periods, and the compilation of the tables, diagrams and report have practically taken up every moment of my spare time for seven months, and even now I have had to leave them in a rather unfinished condition. They have greatly interfered with observing work for the whole of the first half of 1901, and all my astronomical work is now very much in arrear."

The summary of the deduced rotation periods of spots occupies 18 foolscap pages of closely written tables. Capt. Molesworth observed the planet from January to November, altogether on 179 nights, or 60 per cent. of the whole nights in the period. The total number of C. M. transits taken was 6,758.

The following is a copy of the table (very similar to the one in the last Memoir, Vol. VIII., part 4), and contains the gist of all the observations:—

MEAN ROTATION PERIODS IN DIFFERENT ZONES.

Approximate Latitude.	Description of Spots.	Number of Spots.	Average Number of Observations.	Average of elapsed Rotations.	Period.	Total Transits utilised.
					h m s	
−48°	Dark spots in N. edge of S. polar regions.	8	7·45	220	9 55 32·24	38
−43	White spots in S.S. zone	8	7·75	433	9 55 22·21	62
−37	Dark spots in S. temperate belt.	21	14·5	508	9 55 06·60	305
−32	White spots in S. temperate zone.	22	15·4	498	9 55 16·54	339
−26	Dark and white spots in S. tropical belt.	24	17·8	510	9 55 17·22	416
−15 to −21	Dark and white spots along the S. edge of S. equatorial belt.	12	26·9	560	9 55 41·92	323
−11	White spots in central rift of S. equatorial belt.	13	8·1	440	9 51 37·30	106
− 7	Dark spots along N. edge of S. equatorial belt.	28	24·2	601	9 50 22·56	675
− 7	White spots in S. edge of equatorial zone.	18	23·4	561	9 50 21·50	422
± 0	Dark streaks in equatorial band	13	14·6	505	9 50 25·23	190
+ 7	White spots on N. edge of equatorial zone.	20	17·3	509	9 50 25·31	346
+ 7	Dark spots along S. edge of N. equatorial belt.	22	15·0	614	9 50 29·04	331
+10	White and dark spots in central rift of N. equatorial belt.	10	25·1	562	9 55 29·18	251
+13	White and dark spots along N. edge of equatorial belt (normal).	20	35·0	612	9 55 30·47	699
+13	White and dark spots along N. edge of equatorial belt (abnormal).	6	39·5	646	9 55 21·46	237
+21	Dark streaks and spots in N. tropical belt.	13	17·1	496	9 56 00·21	254
+26	White spots in N. temperate zone.	5	7·2	307	9 55 58·97	36
+30	Dark streaks and spots in N. temperate belt.	14	11·0	430	9 55 37·92	153
+35	White spots in N.N. zone.	5	5·8	284	9 55 35·21	29
+41	Dark spots in S. edge of N. polar region.	4	12·7	517	9 55 19·12	51
	Totals	286	—	—	—	5,263
	Average	15·1	18·5	517	—	278·3
	Red spot	3	42·6	693	9 55 41·53	128
	All dark and light spots along N. edge of S. equatorial belt.	46	23·8	585	9 50 22·36	1,097
	All dark and light spots along N. edge of N. equatorial belt.	26	36·0	620	9 55 28·39	926

The Rev. T. E. R. PHILLIPS sends the following notes:—

Rotation Periods.

A statement of the values found for spots situated in the southern portion of the equatorial current is appended.

The periods of spots in other latitudes have not yet been deduced. I am waiting for transits from other observers, and intend to publish the combined results later.

SPOTS AT OR NEAR N. EDGE OF S. EQUATORIAL BELT IN 1900.

Mean Rotation Period = $9^h\ 50^m\ 23^s{\cdot}66$.

Table of Spots.

D = dark spot. W = white spot.

No.	Spot.	Approximate λ at ☌.	Interval between First and Last Observations.	No. of Observations.	Rotation Period.	Remarks.
		°	Days.		h m s	
1	D.	355	157	15	9 50 24·5	
2	W.	5	212	17	9 50 21·7	
3	D.	23	212	21	9 50 22·7	
4	W.	36	221	17	9 50 22·0	
5	D.	47	87	7	9 50 26·0	Did not develop till May.
6	W.	58	87	7	9 50 24·9	Perhaps split off from No. 4.
7	D.	67	196	17	9 50 25·0	
8	W.	82	196	19	9 50 24·3	
9	D.	95	240	21	9 50 22·4	
10	W.	109	180	22	9 50 22·9	Slanting spot with two nuclei.
11	D.	127	201	16	9 50 22·8	
12	W.	140	201	11	9 50 21·9	
13	D.	155	168	16	9 50 20·8	
14	W.	166	168	17	9 50 20·8	
15	D.	184	214	21	9 50 19·9	
16	W.	196	214	20	9 50 19·9	
17	D.	214	214	20	9 50 21·9	
18	W.	229	160	17	9 50 23·2	
19	D.	243	180	18	9 50 25·2	
20	W.	260	219	18	9 50 25·4	Very bright at end of April.
21	D.	285	217	17	9 50 25 9	Large dark mass.
22	W.	300	231	15	9 50 27·1	
23	D.	310	196	9	9 50 25·4	
24	W.	315	58	2	9 50 26·1	Observations very scanty, but identity certain.
25	D.	322	85	11	9 50 26·0	United with Spot 23 at end of August.
26	W.	338	166	13	9 50 26·4	

Summary of last three Apparitions.

			h	m	s
1898	-	Mean of 19 spots =	9	50	24·2.
1899	-	„ 34 „ =	9	50	24·66.
1900		„ 26 „ =	9	50	23·66.

Mean value for the three years = $9^h\ 50^m\ 24^s{\cdot}17$.

PART 4.

SATELLITE OBSERVATIONS.

Observations of the satellites have been received from three of the Members only:—Capt. Molesworth—who says that they have been rather neglected this year in consequence of his attention being more particularly given to observations of spots—the Rev. Theodore E. R. Phillips, Yeovil, and Mr. Scriven Bolton, Leeds.

The observations of the three are combined in the following tabular statement, those of each observer being distinguished by the initial letters M., P., and B. respectively.

PHENOMENA OF JUPITER'S SATELLITES.

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1900.			h m s	h m s		
Jan. 7	I. Ec. D.	Fading	12 29 55	12 30 40	M.	
—	—	Gone	12 31 10			
Jan. 16	I. Oc. R.	Clear	12 10 09	12 02 0	M.	
Jan. 26	III. Sh. E.	First contact.	11 04 05	11 15 0	M.	On disc large, intensely black and circular.
—	—	Off	11 18 05		M.	
Jan. 31	I. Sh. Tr.	On C.M.	11 08 07	—	M.	Circular and black.
—	I. Sh. E.	First contact.	11 58 22	12 02 0	M.	Elongated just before egress. E. to W.
—	—	Off	12 00 57		M.	
Feb. 2	II. Oc. R.	Showing well.	11 44 19	11 48 0	M.	
—	—	Clear	11 47 29			
Feb. 6	I. Oc. R.	First seen	17 55 0	17 55 0	P.	
Feb. 7	I. Sh. Tr.	On C.M.	12 54 42	—	M.	Absolutely round.
—	I. Tr. Im.	First contact.	12 52 02	12 53 0	M.	
—	—	Last contact.	12 54 57			
—	I. Tr.	On disc	13 03 42	—	M.	Sat. still bright.
Feb. 8	I. Oc. R.	First seen	12 22 46	12 24 0	M.	
—	—	Clear	12 25 22			
Feb. 11	IV. near conjunction p. Jupiter to N.		—	--	M.	Very faint and dull, blue tinge very marked.
Feb. 13	III. Oc. D.	First contact	12 25 35	12 31 0	M.	
—	—	Gone	12 40 45			
Feb. 15	I. Ec. D.	Fading	10 53 32	10 55 29	M.	
—	—	Gone	10 55 47			
Feb. 0	III. Ec. D.	Already faint.	11 42 26	11 39 30	M.	
—	—	Gone	11 44 36			

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1900.			h m s	h m s		
Mar 2	I. Sh. Im.	First seen	11 56 07	11 50 0	M.	
—	—	On	11 58 04			
—	—	On disc	12 00 44	—	M.	Distinctly elongated N. to S.
—	—	Do.	12 10 44	—	M	Still elongated.
—	—	Do.	12 30 44	—	M.	Circular; uniformly and intensely black.
Mar. 4	II. Sh. I.	Do.	12 37 43	—	M.	
Mar. 6	II. Oc. R.	Bisected?	11 27 32	11 30 0	M.	
—	—	Clear	11 30 17			
Mar. 10	III. Sh.	On disc	10 22 40	—	M.	Large, circular, and black.
—	III. Sh. E.	First contact.	10 51 50	11 02 0	M.	
—	—	Off	11 05 30			
Mar. 11	I. Tr.	On disc	11 28 39	—	M.	
—	I. Tr. E.	First contact.	11 32 44	11 37 0	M.	
—	—	Off	—		M.	Clouds, not seen.
Mar. 13	II. Oc. D.	Diameter clear.	11 36 22	11 36 0	M.	
—	—	Partly covered.	11 38 52			
—	—	Gone	11 40 22			
Mar. 16	I. Tr. I.	External contact.	16 49 0	16 49 0	P.	
Mar 17	I. Oc. R.	First seen	16 20 0	16 20 0	P.	
—	—	Just clear	16 24 0			
Mar. 18	I. Tr. I.	First contact	11 15 13	11 16 0	M.	
—	—	On	11 18 53			
—	—	On disc	11 28 53	—	M.	Very faint; elongated E. to W.
—	I. Sh. Tr.	On C.M.	11 14 03	—	M.	Very dark, circular, and uniform; smaller than usual.
—	I. Sh. E.	First contact.	12 14 08	12 17 0	M.	Elongated before egress E. to W.
—	—	Gone	12 17 00		M.	
Mar. 20	II. Oc. R.	First seen	16 30 0	16 30 0	P.	Nearing bisection when first noticed.
—	—	Just clear	16 34 0		P.	
Mar. 22	II. Tr.	First seen on disc.	11 07 59	—	M.	Very luminous; larger than when seen against sky.
—	II. Tr. E.	First contact.	11 28 44	11 33 0	M.	
—	—	Gone	11 32 59			
Mar. 28	III. Oc. D.	First contact.	11 51 58	11 59 0	M.	
—	—	Gone	12 08 02			
Mar. 29	II. Tr. I.	First contact.	11 37 12	11 36 0	M.	
—	—	On	11 42 07			
—	II. Sh. E.	First contact.	11 44 07	11 47 0	M.	
—	—	Gone	11 47 42			

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1900.			h m s	h m s		
Apr. 2	IV.	Near conjunction to N.	—	11 20 00	M.	Abnormally faint.
Apr. 3	I. Ec. D.	Fading	11 11 23	11 12 47	M.	
—	—	Gone	11 13 18			
—	I.	On disc, first seen.	11 15 25	—	M.	Distinct; elongated E. to W.
—	—	On disc	11 24 05	—	M.	Very bright; elongated E. to W.
—	—	—	11 26 05	—	M.	Intensely bright; elongation hardly perceptible.
—	I. Tr. E.	First contact.	11 29 55	11 35 0	M.	
—	—	Off	11 33 10			
Apr. 4	III. Ec. D.	Fading	11 17 34	11 23 49	M.	
—	—	Gone	11 28 45			
Apr. 5	II. Sh. I.	First contact.	12 01 36	11 57 0	M.	
—	—	On	12 07 46			
Apr. 17	I. Sh. I.	Just indenting the disc.	12 07 13	12 05 0	M.	
—	—	On	12 10 36			
—	II. Tr. E.	Half off limb.	15 8 30	15 9 0	B.	
—	—	Last contact.	15 10 15			
Apr. 21	II. Oc. R.	First seen	15 15 0	15 16 0	B.	
—	—	Clear	15 19 0			
Apr. 28	I. Oc. R.	First seen	14 16 0	14 15 0	B.	
—	—	Just clear	14 18 45			
Apr. 30	II. Tr. E.	Bisected	12 36 0	12 38 0	B.	
May 3	I. Tr. E.	Do.	13 4 0	13 7 0	P.	
—	—	Just clear	13 8 0			
May 7	II. Sh. I.	Last contact.	11 33 0	11 32 0	B.	
—	—	On C.M.	12 46 40	—	B.	
—	II. Tr. I.	First contact.	12 27 50	12 30 0	B.	
—	—	Bisected	12 29 20			
May 11	I. Oc. R.	Just clear	12 12 0	12 10 0	P.	
—	II.	First noticed on disc.	3 54 36	—	M.	Close to egress; very bright.
—	II. Tr. E.	First contact.	3 55 41	4 02 0	M.	
—	—	Off	3 59 46			
May 14	IV.	Past conjunction to S.	4 20 0	—	M.	
May 15	II. Sh. I.	Fully on disc.	14 10 0	14 6 0	B.	
—	II. Tr. I.	First contact.	14 44 30	14 45 0	B.	
—	—	Bisected	14 46 30			
May 16	II. Oc. R.	First seen	11 13 0	11 15 0	P.	
—	—	Just clear	11 16 0			

Date.	Phenomena.	Phase	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1900.			h m s	h m s		
May 18	II. Sh. I.	First contact.	Not seen	3 24 0	M.	
—	—	On	3 30 12			
—	II. Sh. Tr.	On C.M.	4 36 52	—	M.	Small, circular, and very black.
—	II. Sh. E.	First contact.	Not seen	5 51 0	M.	
—	—	Off	5 49 57			
—	II. Tr. I.	First contact.	3 52 02	3 52 0	M.	
—	—	On	3 57 42			
—	II. Tr. E.	First contact.	6 08 57	6 16 0	M.	
—	—	Off	6 14 32			
May 19	I. Tr. E.	Last contact.	11 2 10	11 1 0	B.	
May 22	I.	On sky	6 00 0	—	M.	Unusually bright.
—	IV.	Do.	6 00 0	—	M.	Rather faint.
May 24	II. Oc. R.	First seen	13 28 0	13 31 0	B.	
—	—	Clear	13 30 45			
May 25	II. Sh. I.	First contact.	6 08 57	5 58 0	M.	
—	—	On	6 14 32			
—	II. Tr. I.	First contact.	6 05 24	6 06 0	M.	
—	—	On	6 10 19			
June 1	II. Tr. I.	First contact.	8 17 55	8 19 0	M.	Very brilliant when on disc.
—	—	On	8 24 20		M.	
—	II. Sh. I.	First contact.	8 35 20	8 32 0	M.	Neat, sharp, black, and circular.
—	—	On	8 41 10		M.	
June 3	I. Ec. R.	First seen	11 56 0	11 56 4	P.	
—	II. Oc. D.	First contact.	2 24 14	2 28 0	M.	
—	—	Gone	2 30 39			
June 4	I. and III.	Conjunction.	5 47 04	—	M.	
June 10	I. Oc. D.	First contact.	11 17 0	11 19 0	P.	
—	—	Just gone	11 21 0			
—	—	Bisected	11 18 0	—	B.	
June 11	I. Tr. E.	Internal contact.	10 33 0	10 40 0	P.	
—	—	External contact.	10 39 5			
—	II. Tr. I.	Do.	11 17 0	11 23 0	P.	
—	—	Internal contact.	11 31 0			
June 13	I. Sh. Tr.	On C.M.	4 19 00	—	M.	
—	I. Tr. E.	First seen	4 58 40	—	M.	
—	—	First contact.	5 03 40	5 06 0	M.	
—	—	Off	5 07 20			
—	I. Sh. E.	First contact.	5 24 25	5 31 0	M.	
—	—	Off	5 27 55			

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1900.			h m s	h m s		
June 15	III. Oc. D.	First contact.	Not seen	1 14 0	M.	
—	—	Gone	1 21 09			
—	III. Ec. R.	First glimpse.	Not seen	4 49 54	M.	
—	—	Bright	5 03 09			
June 16	IV.	Near conjunction to S.	4 50 00	—	M.	
June 17	II. Ec. R.	First seen	10 23 12	10 26 19	B.	
—	—	Fully bright.	10 27 0			
June 19	II. Tr. I.	First contact.	1 56 01	1 55 0	M.	Very brilliant when on disc.
—	—	On	2 00 51		M.	
—	II. Tr. E.	First contact.	4 15 31	4 20 0	M.	
—	—	Off	4 21 26			
—	II. Sh. Tr.	On C.M.	4 03 41	—	M	
June	I. Oc. D.	First contact.	1 56 12	1 57 0	M.	
—	—	Gone	1 59 14			
—	I. Ec. R.	First glimpse.	4 41 02	4 41 41	M.	
—	—	Fully bright.	4 44 54			
June 22	I. Tr.	On disc first seen.	1 08 09	—	M.	Very faint.
--	—	On disc	1 12 39	—	M.	Elongated E. to W.
—	I. Tr. E.	First contact.	1 14 29	1 18 0	M.	
—	—	Off	1 18 19			
—	I. Sh. Tr.	On disc	1 20 0	—	M.	Large, black, and circular.
—	I. Sh. E.	First contact.	1 47 49	1 50 0	M.	
—	—	Off	1 51 34			
—	I. and III.	Conjunction.	2 23 09	—	M.	
—	III. Oc. D.	First contact.	4 26 19	4 33 0	M.	Disappearance very slow owing to obliquity of limb.
—	—	Gone	4 47 09		M.	
June 26	II. Tr. I.	First contact.	Not seen	4 11 0	M.	
—	—	On	4 19 41			
—	—	On disc	5 18 0	—	M.	Still visible.
—	II. Sh .	First contact.	Not seen	5 38 0	M.	
—	—	On	5 37 51			
June 28	II. Ec. R.	First glimpse.	Not seen	2 22 26	M.	
—	—	Fully bright.	2 24 0			
July 3	III. Sh. Tr.	On C.M.	1 34 30	—	M.	Large and black, nebulous at edges.
—	I. Oc. D	First contact.	10 59 30	11 2 0	P.	
July	II. Ec. R.	First glimpse.	4 56 38	4 59 46	M.	
—	—	Fully bright.	5 01 13			

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks
1900.			h m s	h m s		
July 5	II.	On sky	—	—	M.	After reappearance brighter than I.
—	I. Oc. D.	First contact.	5 27 10	5 29 0	M.	
—	—	Gone	5 30 15			
July 10	II. Tr. I.	First contact.	8 53 0	8 48 0	B.	
—	—	Bisected	8 56 30			
—	—	On disc	9 0 0	—	B.	
—	II. Sh. I.	Half on limb.	10 43 45	10 41 0	B.	
—	III. Tr.	On disc	1 45 0	—	M.	
—	III. Tr. E.	First contact.	2 41 02	2 52 0	M.	
—	—	Off	Not noted			
—	III. Sh. I.	First contact.	Not noted	4 38 0	M.	
—	—	On	4 44 42			
—	III. Sh. Tr.	On C.M.	5 34 42	—	M.	Large, circular, and very black, nebulous at edges.
July 13	I. Sh. I.	First contact.	Not noted	5 26 0	M.	
—	—	On	5 29 19			
July 14	I. Ec. R.	First glimpsed.	4 53 34	4 53 46	M.	
—	—	Fully bright.	4 56 52			
July 15	I. Sh. E.	First contact.	2 01 10	2 08 0	M.	
—	—	Off	2 05 20			
July 17	III. Sh. I,	Bisected	8 38 0	8 37 0	B.	Flattened at poles pointed at *f.* end.
—	—	Last contact.	8 47 30		B.	
—	—	On C.M.	9 25 0	—	B.	
—	III. Sh. E.	First contact.	10 19 0	10 44 0	B.	
—	—	Notched	10 40 0			
July 19	I. Oc. D.	First contact.	9 4 0	9 5 0	B.	
—	—	Gone	9 7 0			
July 26	I. Oc. D.	First contact.	10 54 0	10 55 0	B.	
—	—	Bisected	10 56 10			
—	—	Gone	10 57 15			
July 28	II. Sh. Tr.	On disc	5 30 47	—	M.	
—	IV.	Just past	1 16 0	—	M.	Faint and bluish.
—	—	Conjunction to N.	2 26 0	—	M.	Now appearing normal.
July 29	I. Sh. E.	First contact.	5 53 26	5 59 0	M.	
—	—	Off	5 57 31			
Aug. 3	IV.	Nearing conjunction to S.	—	—	M.	Very faint with a decided blue tinge.
Aug. 4	III. Ec. R.	First seen	8 49 0	8 48 41	B.	
—	II. Tr. E.	Bisected	7 41 15	7 42 0	B.	
—	—	Clear	7 44 0			

Date.	Phe-nomena.	Phase.	Observed G.M.T.	Pre-dicted G.M.T. (N.A.)	Observer.	Remarks.
1900.			h m s	h m s		
Aug. 6	I. Oc. D.	First contact.	1 40 33	1 41 0	M.	
—	—	Gone	1 44 07			
—	II. Oc. R.	First seen	2 14 08	2 19 0	M.	
—	—	Clear	2 19 03			
—	II. Ec. D.	Gone	2 23 0	2 21 05	M.	
—	—	Really gone.	2 24 33			
Aug. 12	I. Tr. E.	Internal contact.	8 31 0	8 34 0	P.	
—	—	Just clear	8 35 0			
—	I. Sh. I.	Bisected	7 36 50	7 36 0	B.	
—	—	Fully on disc.	7 38 30			
—	—	On C.M.	8 29 55	—	B.	Circular.
—	I. Tr. E.	Bisected	8 33 0	8 34 0	B.	
—	—	Clear of limb.	8 35 30			
Aug. 13	II. Oc. D.	First contact.	2 18 28	2 23 0	M.	
—	—	Gone	2 24 48			
Aug. 14	I. Sh. Tr.	On C.M.	2 58 27	—	M.	
—	I. Sh. I.	—	2 06 30	2 05 0	M.	
Aug. 15	II. Sh. E.	First contact.	1 53 11	2 06 0	M.	
—	—	Off	1 59 41			
—	III. Sh. Tr.	On C.M.	1 31 26	—	M.	
—	I. Ec. R.	First seen	1 30 16	1 30 01	M.	
—	—	Fully bright.	1 32 26			
Aug. 17	I. and II.	Conjunction	1 00 23	—	M.	
Aug. 20	I. Ec. R.	First seen	8 57 0	8 56 0	B.	
Aug. 27	I. Oc. D.	Bisected	7 23 30	7 22 0	B.	
—	II. Oc. D.	Do.	7 37 15	7 35 0	B.	
Aug. 28	I. Sh. E.	First contact.	8 8 45	8 10 0	B.	
—	—	Bisected	8 10 15			
Aug. 29	I. Oc. D.	First contact.	1 50 31	1 51 0	M.	
—	—	Gone	1 53 56			
—	II. Tr. I.	First contact.	2 12 11	2 06 0	M.	
—	—	On	2 17 31			
Aug. 30	I. Sh. Tr.	Before E	2 24 12	—	M.	Large and black earlier; later appearing very small.
—	I. Sh. E.	First contact.	2 30 12	2 39 0	M.	
—	—	Off	2 33 27			
Sept. 4	I. Sh. I.	Fully on disc.	7 53 0	7 51 0	B.	
Sept. 13	I. Tr. I.	First contact.	2 58 32	3 01 0	M.	
—	—	On	3 02 12			

Date.	Phenomena.	Phase.	Observed G.M.T.	Predicted G.M.T. (N.A.)	Observer.	Remarks.
1900.			h m s	h m s		
Sept.14	II. Oc. D.	First contact.	2 11 53	2 17 0	M.	
—	—	Gone	2 19 13			
Sept.21	I. Oc. .	First contact.	2 09 43	2 10 0	M.	
—	—	Gone	2 12 58			
Sept.22	I. Tr. E.	First contact.	1 46 00	1 43 0	M.	
—	—	Off	1 49 00			
—	I. Sh. Tr.	On C.M.	1 38 00	—	M.	
—	I. Sh. E.	First contact.	2 45 10	2 54 0	M.	
—	—	Off	48 40			
Sept.23	II. Tr. E.	First contact.	1 53 24	1 55 0	M.	
—	—	Off	2 00 04			
—	II. Sh. I.	Bisected	1 49 09	1 45 0	M.	
—	—	On	1 51 24			
—	II. Sh. Tr.	On disc	1 56 0	—	M.	
—	—	—	15 0	—		Normal, small, circular and very black.
—	—	On C.M.	2 49 54	—		
Oct.	I. Tr. E.	Bisected	0 09 56	0 12 0	M.	
—	—	Off	0 11			
—	I. Sh. Tr.	On C.M.	0 52 48	—	M.	
—	I. Sh. E.	—	1 05 45	1 13 0		

Watford, Herts,
May 28, 1902.

ARTHUR COTTAM,
Director of the Section.

JUPITER, 1900.

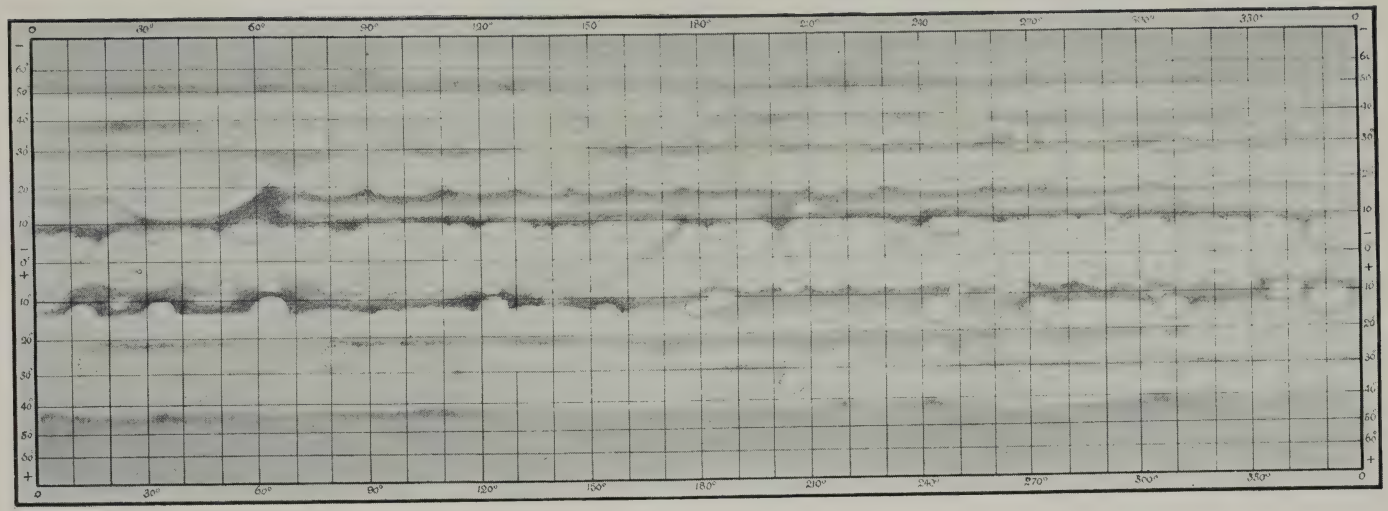


Chart of the markings, reduced to date of opposition (May 27th, 1900); 12½ in. reflector.

P. B. Molesworth, Capt. R.E., F.R.A.S.,
Trincomali, Ceylon.

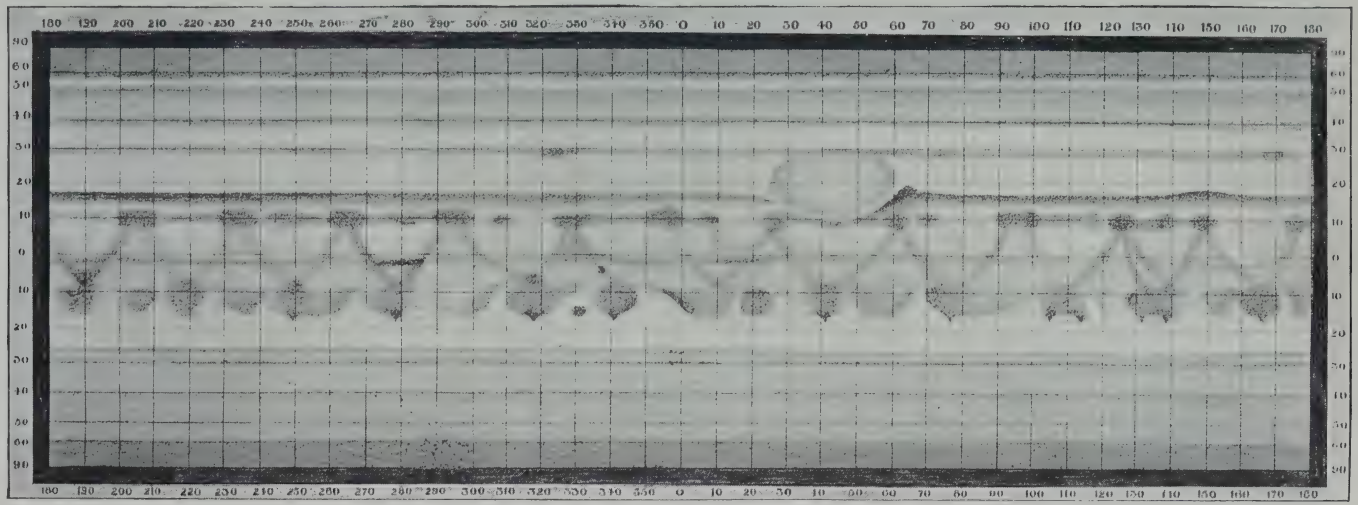


Chart of Jupiter constructed from the drawings made between June and August, 1900, by SCRIVEN BOLTON.

$4\frac{1}{8}$ in. O. G. × 300.

PLATE II.

3 0112 077333539